March 1954

# MECHANICAL ENGINEERING

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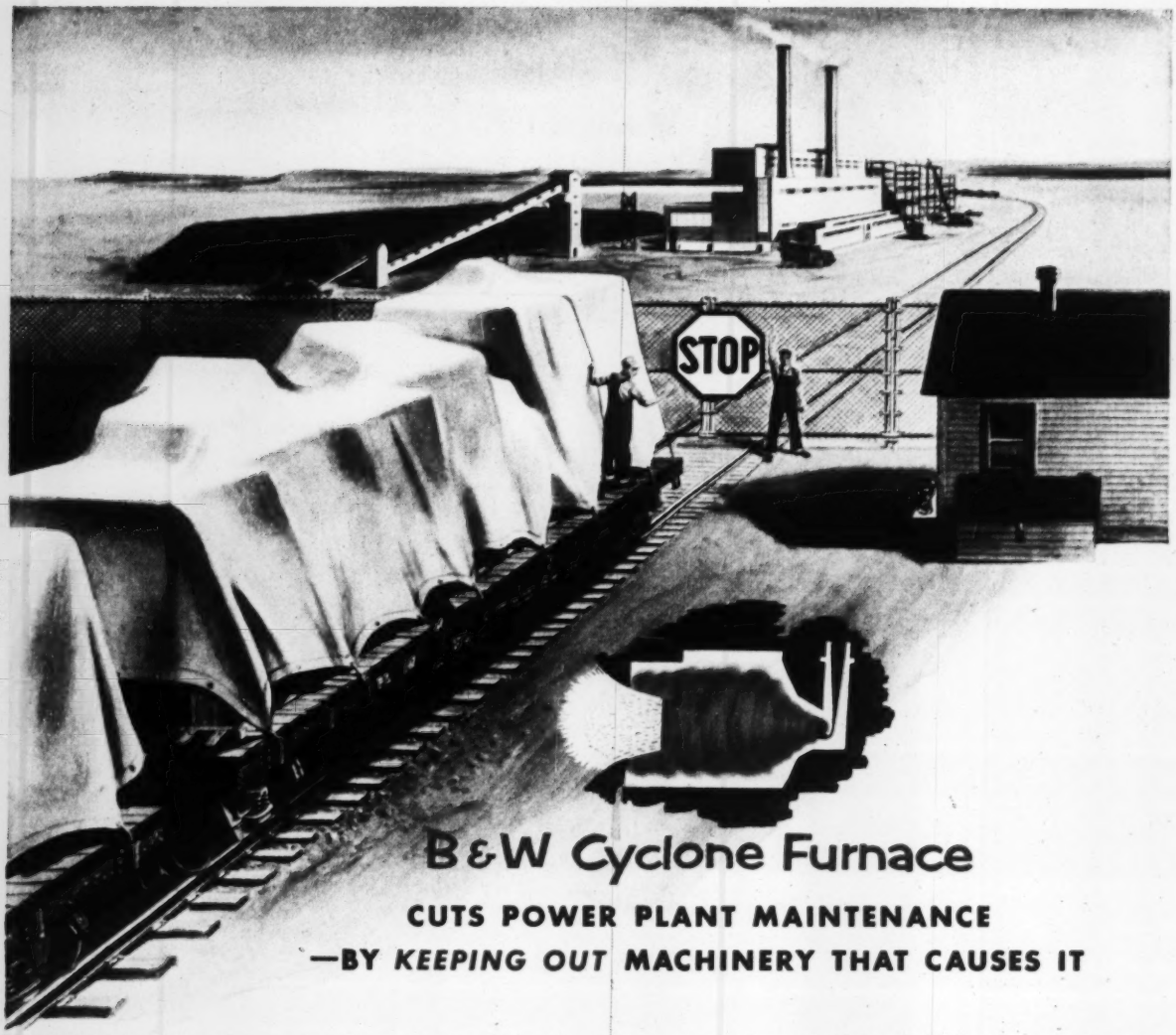



# B&W Cyclone Furnace

## CUTS POWER PLANT MAINTENANCE —BY *KEEPING OUT* MACHINERY THAT CAUSES IT

That trainload of cumbersome coal preparation and ash handling machinery represents a heavy, endless load of costs for many coal-burning power plants. The constant attention and maintenance required by coal pulverizers, with their motors and controls; burners and piping; cumbersome hot-air ducts, fly-ash precipitators and ash collection and disposal systems . . . all add up to expense that can now be eliminated.

Burning coal that is merely crushed, the B&W Cyclone Furnace makes possible substantial savings in maintenance through elimination of much of the coal preparation equipment. And the Cyclone burns coal in such a way as to keep the resulting ash *out* of the boiler and stack . . . converting it into easy-to-handle, easy-to-dispose-of slag . . . thus simplifying or eliminating a considerable share of the ash precipitating, collecting, handling and disposal system.

The Cyclone Furnace offers many other advantages . . . higher combustion efficiency, easier conversion to gas and oil, savings in first cost, increased safety, and simplified arrangement for remote-control operation.

A high percentage of all bituminous coals in the United States can be burned efficiently in the Cyclone Furnace. It can handle a wide variety of coal from mines in all parts of the country. Regardless of where a coal-burning plant may be located, it will have an excellent competitive market in which to purchase coal suitable for firing in the Cyclone Furnace.

Substantial dollars-and-cents benefits are being enjoyed by owners of the many boilers fired with Cyclone Furnaces which are now in operation—under a great variety of conditions—in different parts of the country. Based on this intensive, long-range experience, we will be pleased to discuss with you the many advantages the Cyclone Furnace offers.

The Babcock & Wilcox Company, Boiler Division,
161 East 42nd Street, New York 17, N. Y.

BABCOCK & WILCOX
BOILER DIVISION

N-170

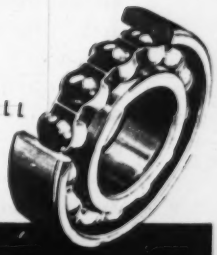
# THE FACTS
## at your fingertips

There is a wealth of **ball** bearing information in New Departure's application literature. This is informative material that will help you get the most out of every ball bearing installation.

Dimensional and capacity data—lubrication, enclosure and maintenance methods. These and many other **ball** bearing facts are yours for the asking.

**Take advantage of New Departure's engineering assistance—New Departure engineers are always—*at your service.***

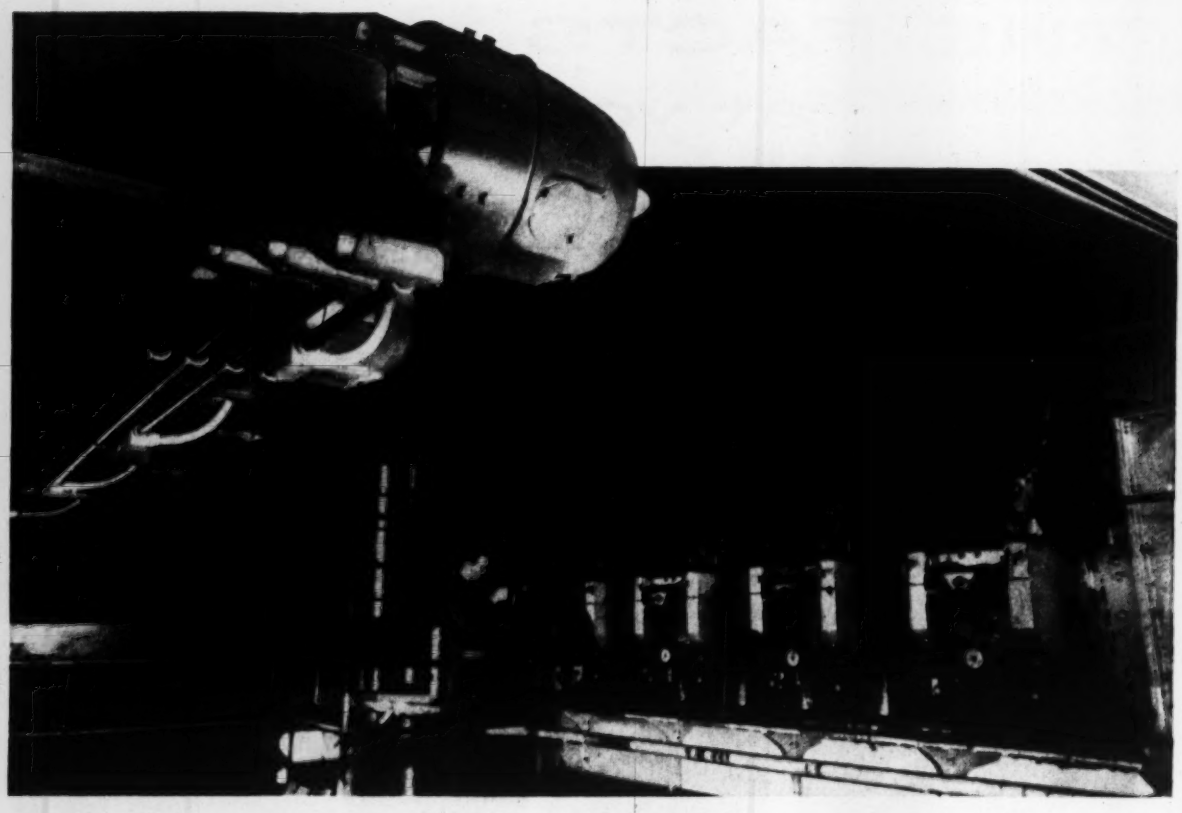
NOTHING ROLLS LIKE A BALL



**NEW DEPARTURE**
**BALL BEARINGS**

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT
Plants also in Meriden, Connecticut, and Sandusky, Ohio


MECHANICAL ENGINEERING, March, 1954, Vol. 76, No. 3. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price to members and affiliates one year $3.50, single copy 50¢; to nonmembers one year $7.00, single copy 75¢. Postage to Canada, 75¢ additional, to foreign countries $1.50 additional. Entered as second-class matter December 21, 1920 at the Post Office at Easton, Pa., under the Act of March 3, 1879. Member of the Audit Bureau of Circulations.



# Drive mounting problems erased with Westinghouse *Life-Line** Gearmotors

Putting the best drive in the minimum space is a problem constantly facing design engineers. In answer to this problem, Westinghouse Life-Line Gearmotors provide unit compactness, rugged construction and job-proved efficiency.

Westinghouse Life-Line Gearmotors have both motor and gears designed as an integral unit. As a result, there's a major saving in space because all belts, chains and pulleys can be eliminated. This means no alignment problems. Since integral design lessens the number of wearing parts, over-all maintenance is cut to a minimum.

With split-case gearmotors, there's no need to allow large work areas for removal or dismantling—all servicing can be done with the gearmotor "on the job". Split-case construction permits the gear cover to be removed in minutes and makes all working parts readily accessible. Any servicing, therefore, becomes a simple, speedy operation.

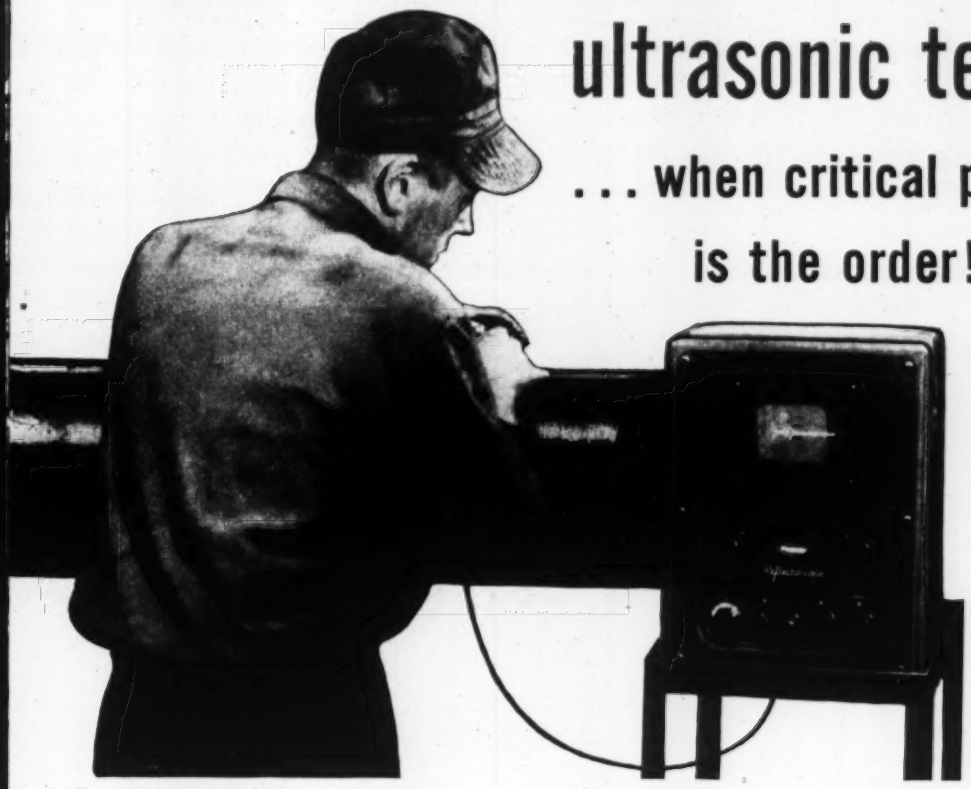
Taper-hardened gear teeth, thorough lubrication and industry-tested Life-Line Motors are but a few of the features which assure long, dependable performance from Westinghouse Gearmotors.

Your local Westinghouse Representative will gladly furnish you with additional information. Call him at any time or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. *Trade-Mark J-07322

YOU CAN BE SURE...IF IT'S Westinghouse

# Consider the basic advantage of ultrasonic testing

## . . . when critical piping is the order!



Experienced power engineers have for years been aware that alloy power piping is subject to defects which can not be revealed by conventional inspection methods. But to radiograph whole lengths of piping would be prohibitively expensive.

As a result there were occasional failures. Subsequent investigations showed that internal cracks rather than improperly welded joints were usually the cause of rupture. Such flaws would not be detected by any normal inspection methods.

To meet this problem, Kellogg, in collaboration with a large user of this class of material made investigations of inexpensive, non-destructive testing techniques which would reveal indications of hidden flaws. This program resulted in the introduction of commercial ultrasonic testing of alloy piping.

Today Kellogg uses the method extensively on high-temperature, high-pressure power piping before it is fabricated in the shops. As a successful and low cost method of putting a finger on possible injurious defects with startling accuracy, its usefulness is well documented. In view of the steadily increasing temperatures and pressures demanded by the economics of modern power generation, the value of this development is obvious.

This approach to the problems of fabricating the highest quality power piping—the willingness to explore new techniques, develop new methods—is basic to Kellogg's operation. Many power station designers and utility companies also say it's the basic reason why they repeatedly specify *"critical piping by Kellogg"*.

**These leading companies are among the many major producers of power who use M. W. KELLOGG POWER PIPING . . .**

- American Gas & Electric Service Corp.
- Boston Edison Co.
- Central Hudson Gas & Electric Co.
- Chaudronneries A. F. Smulders (Belgium)
- Compania Argentina De Electricidad
- Compania De Fuerza Del Sureste De Mexico S.A
- Consolidated Edison Co. of N. Y.

**OTHER FABRICATED PRODUCTS include:** Pressure Vessels . . . Vacuum Vessels . . . Fractionating Columns . . . Drums and Shells . . . Heat Exchangers . . . Process Piping . . . Bends and Headers . . . Forged and Welded Fittings

**FABRICATED PRODUCTS DIVISION**
**M. W. KELLOGG**

M. W. KELLOGG — Subsidiary of PULLMAN Incorporated

# NOTES

... the engineer's note book

## . . . ON WHEELER-ECONOMY POWER PLANT EQUIPMENT

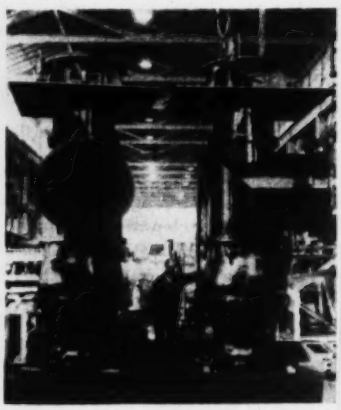
### NO SHUTDOWN, NO LOAD REDUCTION, NO HAND CLEANING . . . WITH C. H. WHEELER *REVERSE FLOW* CONDENSERS

The savings in dollars and downtime effected by C. H. Wheeler's Reverse Flow design for steam condensers are a matter of record in public utilities and private power plants throughout the country. Chances are, you can inspect a nearby installation and learn first hand how efficiently debris of vegetable, animal and mineral matter is dislodged from the tube sheet and flushed away by reversing the flow of the cooling water through the Condenser. Cleaning work that formerly took hours is accomplished in minutes with no interruption in load. C. H. Wheeler custom-engineers your steam condensing hook-up to pay off in long range sustained efficiency. (Bulletins mailed on request.)

### WHEELER - ECONOMY CIRCULATORS

***Lasting Dependability***
***Minimum Maintenance***

Wheeler-Economy Circulators include: mix-flow vertical wet pit type with both standard and pull-out design; vertical mix-flow volute type for dry pit installations; and horizontal single stage centrifugal constructions to 100,000 GPM capacities. Wheeler-Economy pumps for general service include: single stage high head double suction; multi-stage with horizontal or vertical split case; pumps for sump,



process and fire protection services. Wheeler-Economy also invites your special problems requiring custom design. (Bulletins mailed on request.)

### TUBEJET AIR EJECTORS

***Steel Shell***
***More Reliable***

C. H. Wheeler Steel Shell Tubejet Air Ejectors provide worthwhile savings in space and weight. They are available with either single or multiple element, two-stage type with combined surface inter-after condenser. Write for Bulletin.

### WHEELER-ECONOMY CONDENSATE PUMPS for Condenser Service with Turbine and Motor Drive

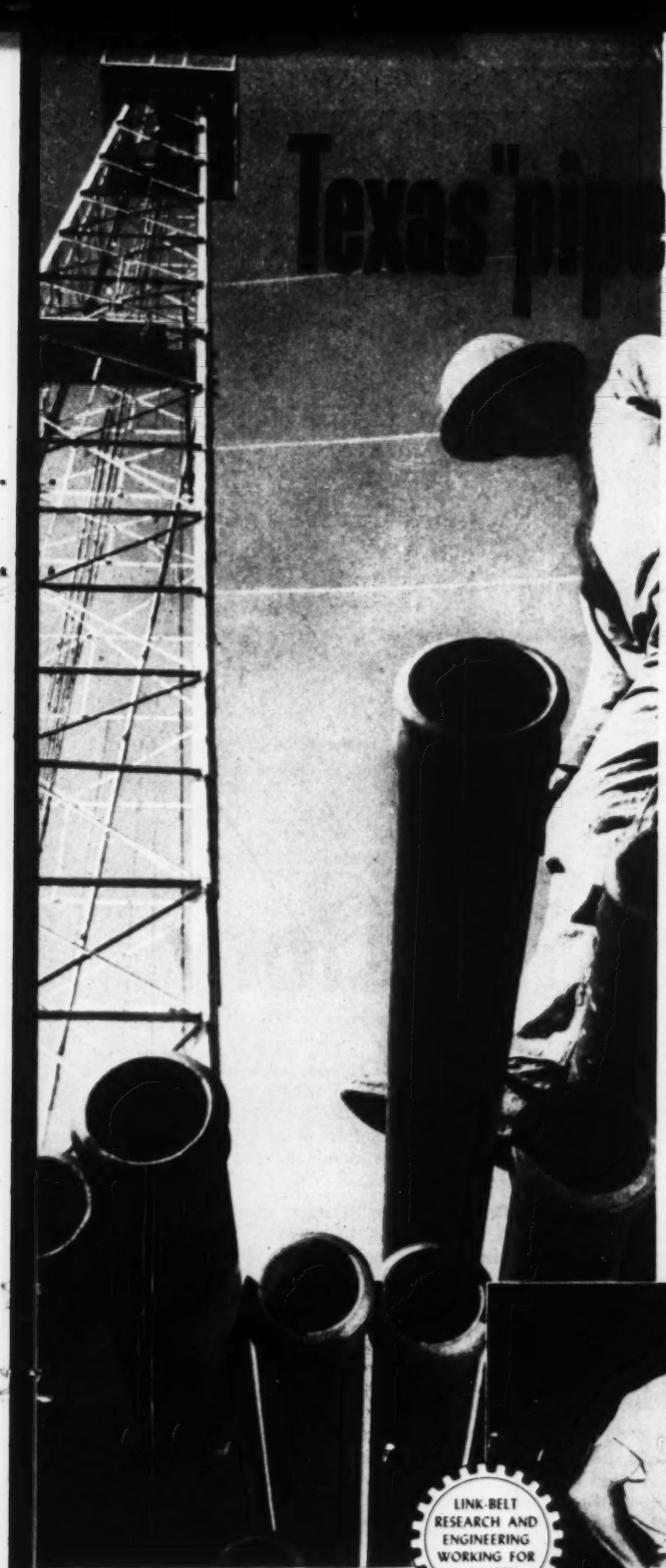
*Write for Bulletins*

WE-400

# C. H. WHEELER *of Philadelphia*

**C. H. WHEELER MANUFACTURING CO., 19th & LEHIGH, PHILADELPHIA 32, PENNA.**

Steam Condensers • Centrifugal, Axial and Mixed Flow Pumps • Steam Jet Ejectors • Vacuum Refrigeration
High Vacuum Process Equipment • Micro-Particle Reduction Mills • Marine Condensers and Ejectors • Deck Machinery



# Texas "pipe dream" comes true!

***Link-Belt bearings, chains and enclosed drives chosen for Texas' newest pipe mill***

MOST recent addition to Texas' mushrooming industry is Lone Star Steel. To help meet the demands of drillers and pipeliners, it is now turning out thousands of feet of pipe daily. And throughout the two half-mile-long production lines, Link-Belt bearings, chains, flexible couplings and enclosed drives are used.

Link-Belt equipment operates under tough conditions—high temperatures . . . heavy, continuous loads . . . frequent, severe impact. That's why many of the manufacturers of important equipment for Lone Star independently specified Link-Belt products . . . why the designing and supervising engineers, A. J. Boynton & Co., approved them.

If you transmit power or move materials . . . whether your requirements are simple or complex—Link-Belt offers you a single source for a broad line of high quality equipment. For complete engineering cooperation, call the Link-Belt office near you. Like thousands of other men throughout industry, you'll find it pays to rely on Link-Belt.

**LINK-BELT**

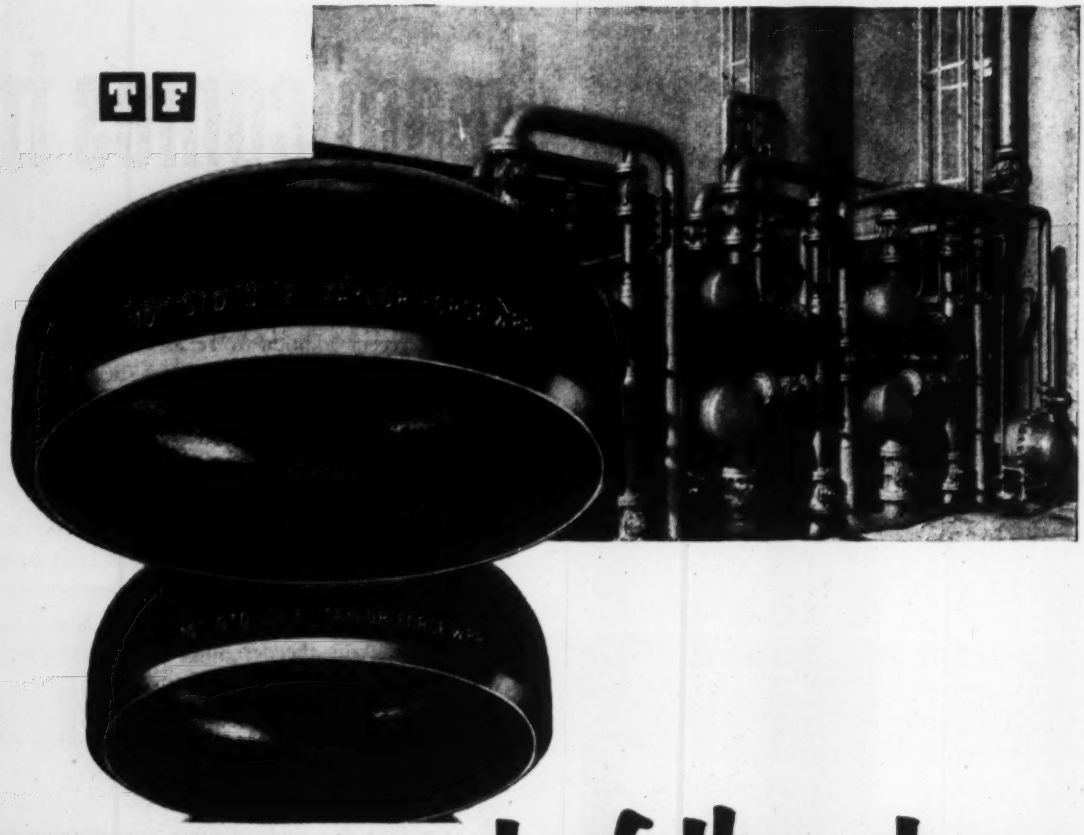
**One source . . . one responsibility for materials handling and power transmission machinery**

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants, Sales Offices, Stock Carrying Factory Branch Stores and Distributors in All Principal Cities. Export Office: New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 13.429

LINK-BELT RESEARCH AND ENGINEERING WORKING FOR INDUSTRY

As far as the eye can see—Link-Belt "mill bearings" (roller bearing cast steel pillow blocks), helical gear drives and flexible couplings are used on roller conveyors built by Enterprise Co., Columbiana, Ohio, for use at Lone Star Steel Co.'s pipe mill. Also used are Link-Belt herringbone, worm, fluid and P.I.V. variable speed drives and chains on cooling and transfer beds.

T F



# Caps are part of the story

The announcement of the WeldELL line, back in 1931, created a considerable sensation in the piping field. Pipe welding was then just beginning to emerge from the crude, cut-fit-patch stage and the only welding fittings then in use were simply elbows.

But here was a *full line* of welding fittings—not only the long and short radius ells, but also full branch and reducing tees, concentric and eccentric reducers, stub ends, welding neck flanges . . . even *caps!*

You know what happened: The WeldELL line had taken pipe welding out of darkness into light . . . had provided the impetus and set the pattern of modern pipe welding practice.

Yes, the WeldELL line was the first complete line—the first engineered line . . . and the fittings that showed the way are still showing the way. For up-to-the-minute facts about the WeldELL line see your Taylor Forge Distributor.

# TAYLOR FORGE

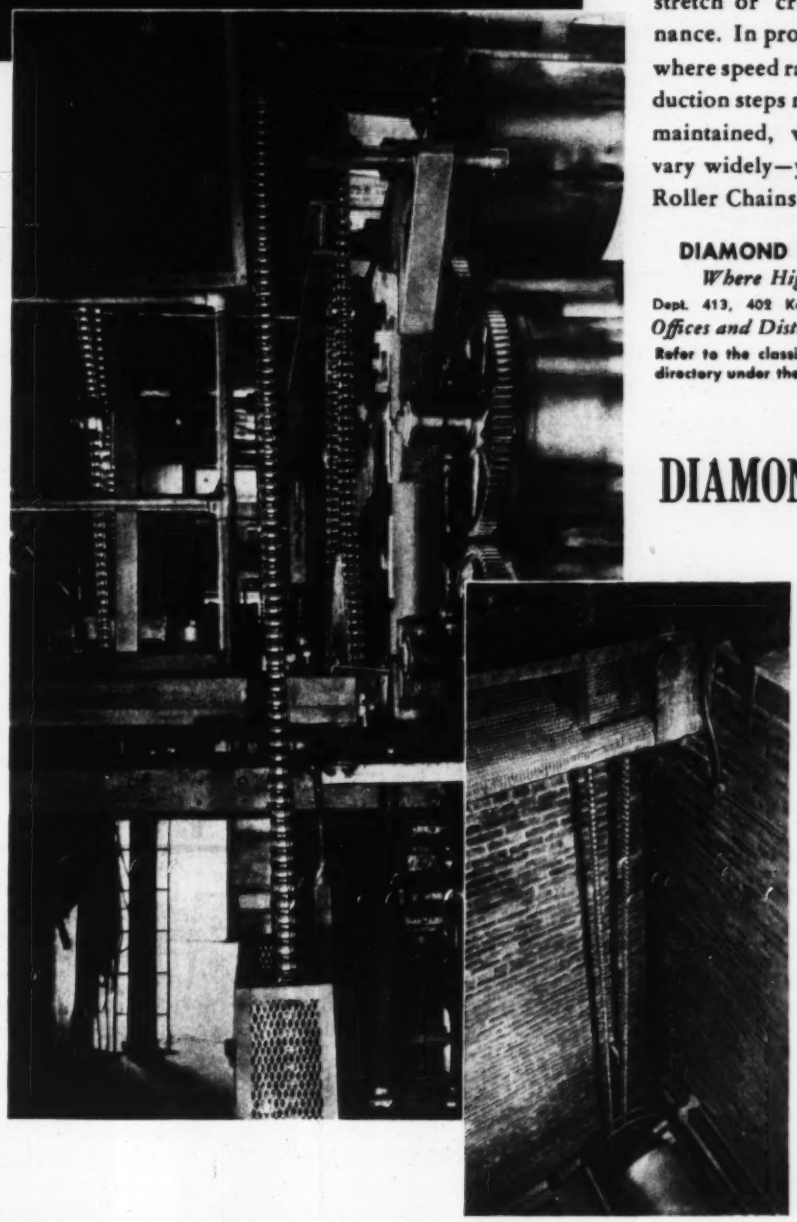
**TAYLOR FORGE & PIPE WORKS**

General Offices and Works: P. O. Box 485, Chicago 90, Illinois

Offices in all principal cities • Plants at: Carnegie, Pa.; Fontana, Calif.; Gary, Ind.; Hamilton, Ont., Can.

# LONG DISTANCES BETWEEN SHAFTS?

## . . . no problem at all, with Diamond Roller Chains



The two illustrations below show how the engineers of a large flooring product manufacturer coordinated operation of specialized equipment by means of Diamond Roller Chains.

Shafts far apart—on different floors—were driven with the positiveness of gears, with speed ratios selected and maintained to insure the proper rotation of series of drums in the continuous manufacturing process.

With Diamond Roller Chains long-life dependability is insured—there is no stretch or creep—little or no maintenance. In processing plants of all kinds where speed ratios between successive production steps must be accurately set and maintained, where shaft distances may vary widely—you too will find Diamond Roller Chains readily adaptable.

**DIAMOND CHAIN COMPANY, Inc.**
*Where High Quality is Traditional*
Dept. 413, 402 Kentucky Ave., Indianapolis 7, Indiana
*Offices and Distributors in All Principal Cities*
Refer to the classified section of your local telephone directory under the heading CHAINS or CHAINS-ROLLER

DIAMOND ROLLER CHAINS

Write for New Catalog 753 which lists all standard Chains and Sprockets.

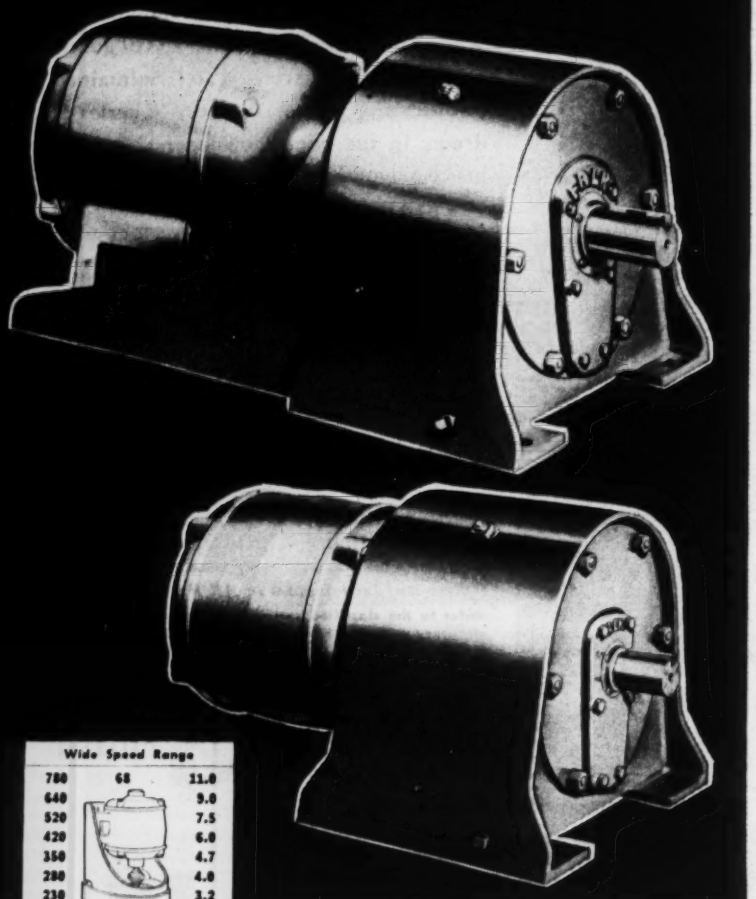


Note the long shaft center distances and variety of Diamond Roller Chain applications.

# Both... egral toreducers

## use *complete* motors with *no* modifications

**...another important reason why you should consult FALK!**



| Wide Speed Range | | |
|---|---|---|
| 780 | 68 | 11.0 |
| 640 | | 9.0 |
| 520 | | 7.5 |
| 420 | | 6.0 |
| 350 | | 4.7 |
| 280 | | 4.0 |
| 230 | | 3.2 |
| 190 | | 2.7 |
| 155 | | 2.2 |
| 125 | | 1.8 |
| 100 | | |
| 84 | | |

Your customers never have the annoying problem of motor modification when you standardize on *all-steel* FALK Motoreducers. Both the universally popular All-Motor type and the newly redesigned Integral type use *completely standard motors without modification.* The motor can be quickly and easily replaced by another standard motor of any make, type or speed within the unit's AGMA rating when necessary without disturbing the reducing unit.

Many choose the All-Motor type because it permits easy interchange of motors, or *even parts,* on the job, *in minutes*—with a minimum of down time. Others like the new Integral type with standard D-flange NEMA motor because it is a highly compact, streamlined unit providing the utmost in space economy.

In every FALK Motoreducer—All-Motor or Integral—the output speed (ratio) can be changed within the unit's torque capacity without modifying the motor.

Both types contribute to your industrial equipment all the quality, adaptability, dependability and long-range economy for which FALK has been celebrated for more than sixty years. FALK Motoreducers are available in standard ratio for stock shipment. Write to Dept. 247.

**Every FALK Motoreducer has these "In-built" Factors—**

**Wide Speed Range.** Selective ratio combinations provide output speeds from 1.5 rpm to 1430 rpm with stock gears.

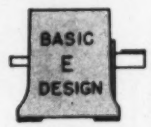
**Sealed Housings.** Dual closures and one-way vents keep oil *in,* dust and moisture *out.* Units are splash-proof, leakproof, dustproof.

**Precision Gearing.** Heat treated alloy steel, precision cut and shaved helical gearing throughout . . . quiet-operating crown shaved pinions . . . taper bored gears for easy ratio changes.

**All-steel Housings.** Unbreakable, strong, rigid. Generous overhung load capacities provided by wide bearing spans, large shafts and bearings.

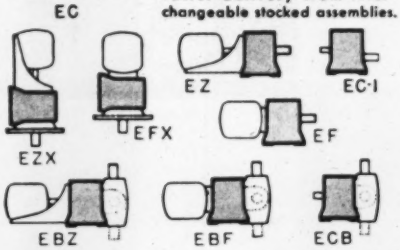
**Streamlined inside and outside.** Smooth, clean surfaces; machine welded construction conforms to NEMA motor frames.

**Positive Lubrication.** Large sump capacity . . . oil-tight construction assures clean lubricant . . . direct dip of revolving elements provides positive lubrication at all speeds.




EC

**The basic E design permits maximum use of standardized parts . . . closer control over materials, processing, inspection and assembly . . . resulting in faster delivery from interchangeable stocked assemblies.**




# FALK ...a good name in industry

**THE FALK CORPORATION 3001 W. Canal St. Milwaukee 8, Wis.**

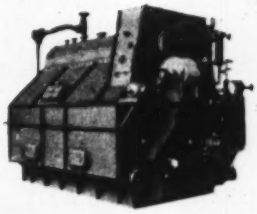
# 100th ANNIVERSARY WICKES BOILERS 1854-1954

Early photograph of Wickes' shop force

The year was 1854. Franklin Pierce was President. Stephen A. Douglas was leading a fight to abolish the Missouri Compromise on slavery. The railroads were beginning their first westward expansion . . . just the year before, rail connection had been established between New York and Chicago. Only 10 years before, Samuel F. B. Morse had invented the telegraph, and new inventions were rapidly changing the face of American industry. Large scale production was at hand, and industry stood on the threshold of a new, remarkable era.

Though the first Wickes Boilers would look crude indeed alongside the highly efficient units Wickes makes today, they were quite advanced for their time, and industry soon learned that the name Wickes stood for dependable low-cost steam production. Through constant research, expansion of manufacturing facilities and the introduction of modern production techniques, Wickes has maintained that position of leadership for the last 100 years.

Today, Wickes can supply your requirements for steam generators capable of producing 500,000 lbs. steam per hour at pressures up to 1000 psi. — all types of multiple drum boilers adaptable to any standard method of firing. For pressures up to 900 psi., with sustained steam production up to 40,000 lbs., Wickes Type A Boilers can be shop-assembled, ready for immediate installation. Consult your nearest Wickes representative or write today for descriptive literature.



**WICKES** THE WICKES BOILER COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN

RECOGNIZED QUALITY SINCE 1854

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152

# Vibration testing made easier

Electronic component under test at Eclipse-Pioneer division of Bendix Aviation Corporation.

## *with the help of MB equipment like this*

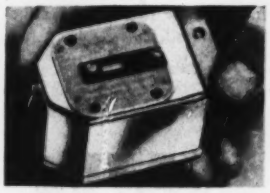
Do you have to vibration-test your product to meet military specifications? Want to apply shake-testing to improve product design or to control quality? If so, do what many leading companies have done – enlist the help of MB.

First, you get the right equipment. MB offers a *complete* line of vibration exciters from 10 pounds force all the way to the largest developed today – 10,000 pounds! All are quality built to stand up and do the job right to specifications. Electromagnetic in operation, they're easily and quickly adjusted for force and frequency. And, second, you get the benefit of MB's wide experience in applying this relatively new and valuable technique for product improvement.

Among the well known companies working with MB products, Bendix Aviation Corporation's Eclipse-Pioneer division is outstandingly equipped with *several* MB Vibration Exciters. The photograph shows one – MB Model C-25, rated at 2500 pounds of force – vibrating an electronic component to insure dependability under severest conditions. Such testing can uncover, in minutes, trouble that might take months to develop.

### VIBRATION PICKUP ANOTHER USEFUL TESTING TOOL

When you want to detect vibration and determine its nature, you'll want an MB Vibration Pickup. While the pickup detects even slightest vibratory motion, it was built for grueling service as well. Model 122 withstands temperatures up to 500°F.



Control panels for all MB shakers, as in the photo above, can be furnished with MB Vibration Meter for use with pickup. This meter gives direct velocity, acceleration and amplitudes of the picked-up vibration.

**Bulletins you'll welcome**

How to calibrate vibration pickups to 2000 cps – Bulletin C-11-4 reviews the subject comprehensively. Bulletin 1-VE-4 tells all about MB Vibration Exciters. Write for them.

**THE MB MANUFACTURING COMPANY, INC.**
1060 State Street, New Haven 11, Conn.

HEADQUARTERS FOR PRODUCTS TO INDUCE VIBRATION...TO MEASURE IT...TO ISOLATE IT

# *"At the Waldorf-Astoria, we're replacing pipe runs with Wrought Iron"*

— *says* THOMAS J. BARRETT,
Building Superintendent

MR. BARRETT'S insistence on durability in steam return lines at the famous Waldorf-Astoria is an economy measure that pays off not only in lower maintenance but also in guest room availability.

In all hotels, steam return failures can take a large share of the maintenance budget dollars. But that would be only part of the cost story at the Waldorf. If one steam return fails, from 25 to 30 guest rooms are removed from the reservation list until the piping has been repaired. As a safeguard against this costly result of premature pipe failure, the Hilton Management has standardized on wrought iron pipe for all horizontal and vertical steam return replacements.

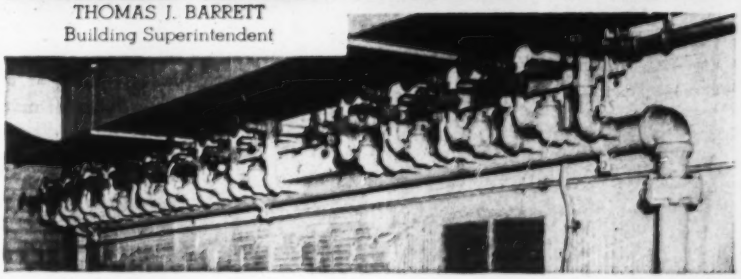
The wisdom of this choice is supported by outstanding wrought iron durability records in steam return lines in industrial, commercial and institutional buildings in every section of the country. Architects, engineers and designers, well aware that corrosion cannot be eliminated as a factor influencing pipe service life in steam return lines, even under the best operating conditions, are regularly specifying wrought iron pipe for the service. The continued acceptance by these professions is the best possible evidence of wrought iron pipe's ability to last longer, at lower cost per year.

If you are concerned with steam return piping, and would like a detailed report on how wrought iron can serve you better, write our Engineering Service Department. Your request will be handled promptly.

A. M. Byers Company, Pittsburgh, Pa. Established 1864. Boston, New York, Philadelphia, Washington, Atlanta, Chicago, St. Louis, Houston, San Francisco. Export Department: New York, N.Y.



THOMAS J. BARRETT
Building Superintendent



# BYERS

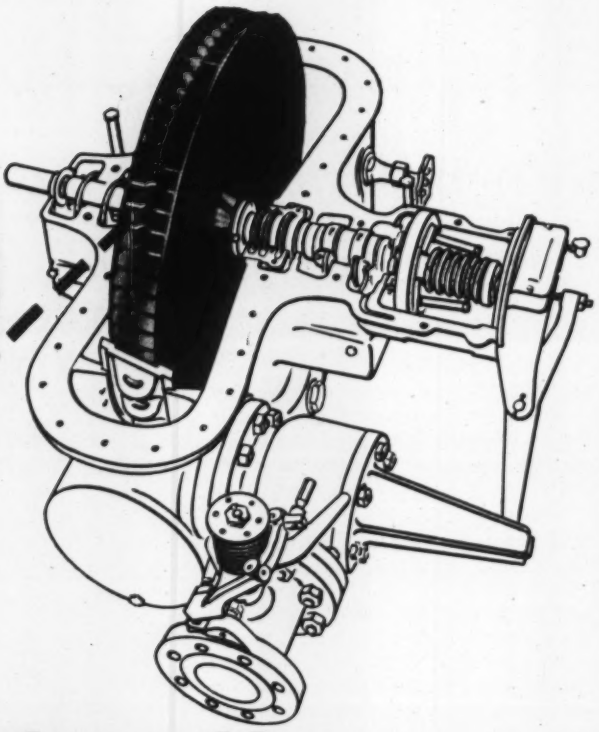
CORROSION COSTS YOU MORE THAN WROUGHT IRON

**WROUGHT IRON**

**TUBULAR AND HOT ROLLED PRODUCTS**

ELECTRIC FURNACE QUALITY ALLOY AND STAINLESS STEEL PRODUCTS

# TERRY SOLID WHEEL



## ..."trade mark" of a trouble-free turbine

This is the rotor of a Terry solid-wheel turbine. There are a number of reasons why it has become a symbol for reliable, trouble-free operation.

**First,** because the wheel is a single forging, in which a series of semi-circular buckets is milled, there are no separate parts to become loose or work out.

**Second,** because the power-producing action of the steam takes place on the curved surfaces at the back of the buckets, blade wear is of little consequence. Wear does not materially affect horsepower or efficiency.

**Third,** because the steam enters the buckets in a direction at right angles to the shaft, there is no need for close axial blade clearances. The blades cannot foul. There is a one inch clearance on either side of the wheel. In addition, the blades are double rim protected.

These are only a few of the reasons why the Terry solid wheel has become a "Trade Mark" for trouble-free turbine performance. For complete details, send for a copy of bulletin S-116. No cost or obligation.

**THE TERRY STEAM TURBINE CO.**
**TERRY SQUARE, HARTFORD 1, CONN.**

TERRY

TT-1197

# How Servel Water Chillers

# *Solve your Cooling Problem*

**1**

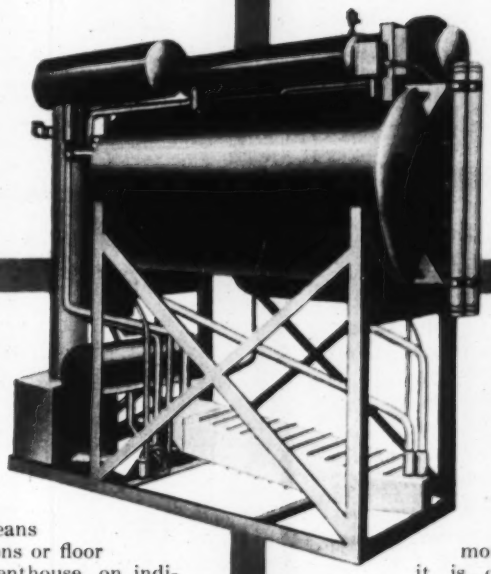
***Regardless of cooling needs***

The adaptable Servel 25-ton Water Chiller uses water as the refrigerant—provides economical cooling for *air conditioning, process cooling,* or *industrial pre-cooling.* Your Servel dealer can show you performance figures on applications most similar to your needs, in any of the three fields.

**2**

***With the most economical fuel***

Steam from the most economical source—gas, oil, LP gas, even *waste* heat—operates the unit, by Servel's exclusive, no-moving-parts *absorption* principle of refrigeration. This wide choice assures you of low operating costs . . . as does Servel's high operating efficiency.



**3**

***Under every installation situation***

Light floor loading and vibrationless operation means that no special foundations or floor braces are needed—in penthouse, on individual floors, or in basement. Simple piping, instead of expensive duct work, cuts installation time and costs. Zone control is unusually easy.

**4**

***With exclusive assurance of satisfaction***

The Servel Water Chiller cooling system has no moving parts to wear, thus it is quiet and vibration-free. Every Servel Water Chiller is backed by a 5-year warranty. See your Servel dealer or mail coupon for information and engineering co-operation.

**MAIL NOW FOR COMPLETE DETAILS!**

Servel

*the name to watch for great advances in*

AIR CONDITIONING ✓ REFRIGERATION

**SERVEL, INC., Dept. ME-34 Evansville 20, Indiana**

Please send me complete information on Servel equipment for ☐ Air Conditioning, ☐ Process Cooling, ☐ Industrial Precooling.

Name _____

Firm _____

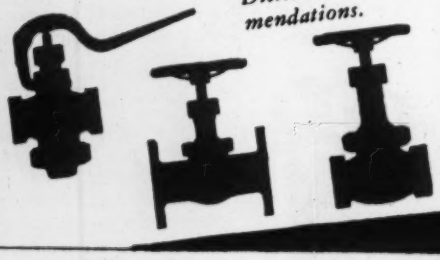
Address _____

City _____ County _____ State _____

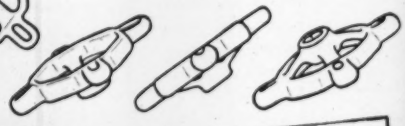
**WHAT TO LOOK FOR**

# when you buy a Bronze Valve

**1 LOOK FOR DESIGN.** Use the right valve for the right type of service at the right pressure. There is no such thing as an "all-purpose valve" . . . so don't try to make *one* valve do. *In the complete Lunkenheimer line, there are 125 basic bronze valves — each ideal for a certain type of service. Get your Lunkenheimer Distributor's recommendations.*



**2 LOOK FOR OPERATING FEATURES,** particularly those that make the valve longer-lasting and easier to use, such as the handwheel. *Lunkenheimer patented Non-Slip® Handwheel assures a firm, cool grip—makes it easy to close the valve tight, reducing wear and eliminating leakage. All Lunkenheimer Bronze Valves have the new Non-Slip Handwheel, along with many other exclusive operating features.*



**3 LOOK FOR A LONG-WEARING STEM,** since stem-thread wear is one of the most common causes of valve failure. *Lunkenheimer Bronze Valves have Stemalloy® Stems — an exclusive silicon-bronze alloy which completely eliminates stem-thread failure. Not one of the millions of Stemalloy Stems now in service has ever been returned because of thread wear.*

**4 LOOK FOR CLOSE-GRAINED BRONZE,** the mark of valve quality. Dense bronze not only increases the valve's strength, but makes it much more resistant to corrosion. *Lunkenheimer Bronze Valves are made of original Lunkenheimer alloys recognized by metallurgists as the highest-grade valve bronzes ever developed.*

*Remember—The Price Of A Lunkenheimer Valve Gets Smaller And Smaller And Smaller With Each Passing Year Of Dependable Service*

**ALL POPULAR SIZES** of Lunkenheimer Bronze Valves are maintained in stock for prompt delivery. Write for new Circulars 534, 582, and 574 describing typical designs. The Lunkenheimer Co., Box 360E, Cincinnati 14, Ohio.

LUNKENHEIMER L® QUALITY

**BRONZE • IRON • STEEL**

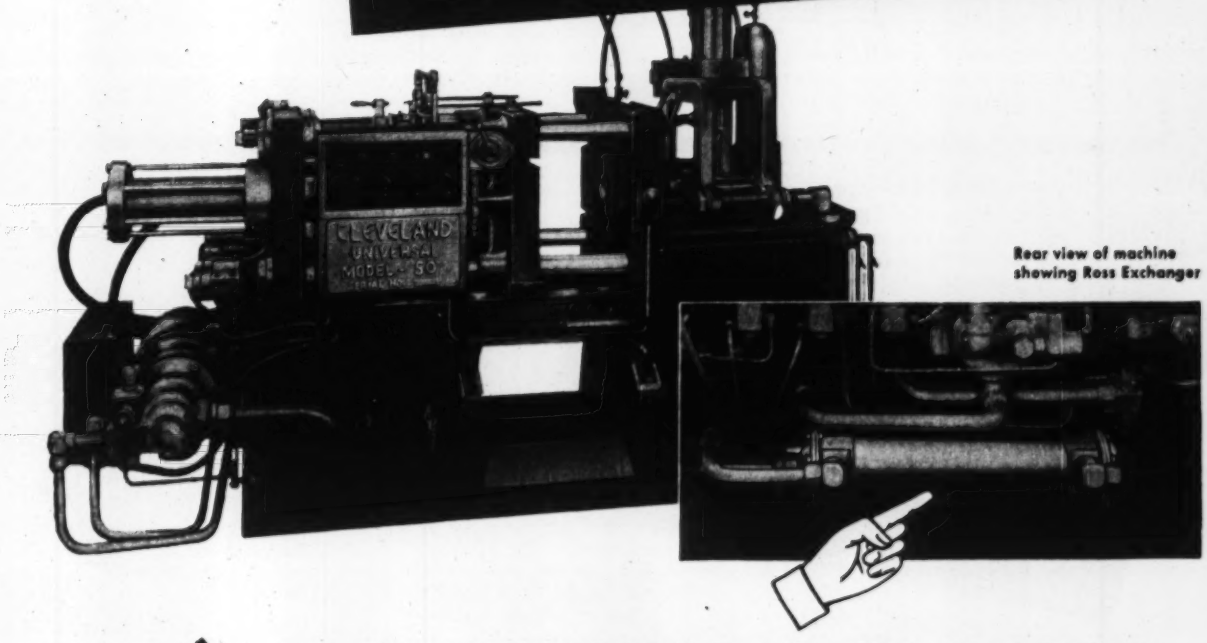
# LUNKENHEIMER®

THE ONE *Great* NAME IN VALVES

L-154-15

# OIL TEMPERATURE REMAINS CONSTANT

## while this Cleveland Die Casting Machine cycles 1000 shots per hour




Rear view of machine showing Ross Exchanger

# IT'S ROSS EXCHANGER EQUIPPED

With a locking pressure of 50 tons, this Cleveland Model 50 Universal Die Casting Machine has been designed to cycle over 1000 times per hour. To prevent excessive fluctuations in oil temperature, which would tend to cause variations in hydraulic performance, a Ross Type BCF Exchanger has been installed. The full 44.2 gpm capacity of the machine's high pressure, two-stage pump is thus insured!

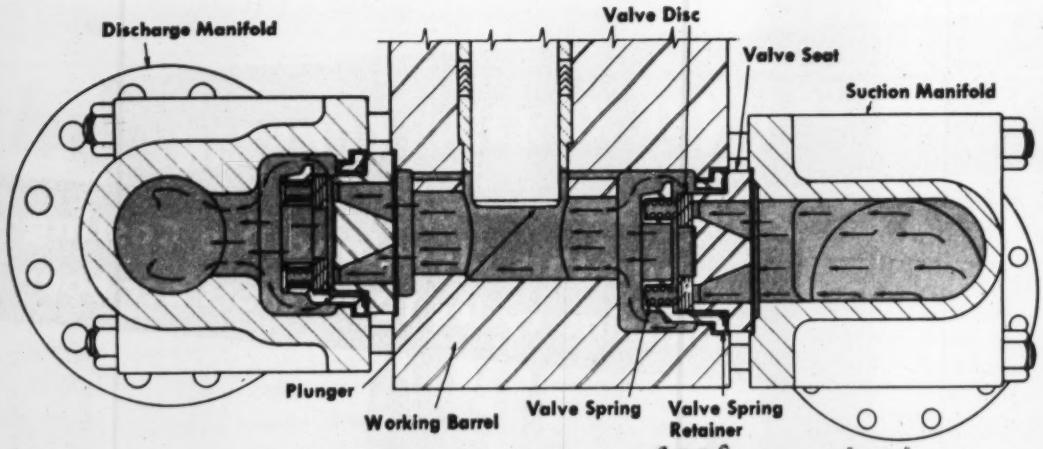
Says The Cleveland Automatic Machine Company: "Ross Exchangers have done a fine job on Cleveland Die Casting Machines. We have standardized on the Ross Exchanger for our Model 50, because it is compact and we need this space-saving feature especially on this small size machine."

Regularly selected by leading manufacturers of numerous types of major equipment for their high thermal efficiency, Ross Exchangers are ruggedly built to withstand punishing hydraulic shock. Tough, ductile seamless copper shells and brass forgings can well absorb the extra load.

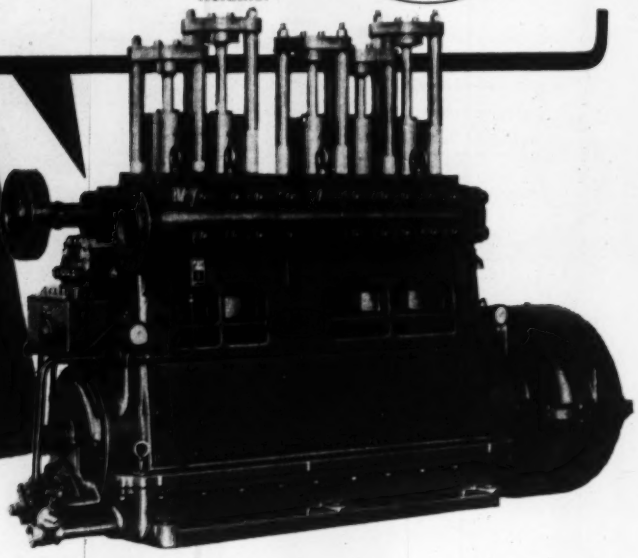
Pre-engineered and fully standardized in a wide range of sizes, Ross Type BCF Exchangers are available with "off-the-shelf" promptness to meet most needs. For detailed information, request Bulletin 1.1K5.

KEWANEE-ROSS CORPORATION
DIVISION OF AMERICAN RADIATOR & STANDARD SANITARY CORPORATION
1448 WEST AVENUE • BUFFALO 13, N. Y.
In Canada: Kewanee-Ross of Canada Limited, Toronto 5, Ont.

*Serving home and industry:* AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS • SUNBEAM AIR CONDITIONERS




# ENGINEERS: Check these points of Aldrich Direct Flow Design



Aldrich engineers eliminated two right-angle turns in the fluid-end. Now, liquid passes from suction to discharge manifold in a *straight line.* That gave the Direct Flow Pump its name, and set up a whole new concept of pumps, pumping, and pump maintenance. It all adds up as follows:

☐ **Increased operating speeds**—you get whatever volume and pressure you need *from a smaller, lighter, more compact pump.*

☐ **Sectionalized construction**—parts can be replaced at a fraction of the cost of a new fluid-end; also, parts can be made of stainless, bronze, Monel or other special materials—extremely important for corrosive fluid service.

☐ **Maintenance made easier**—no more tapered bores in the working barrel. Manifolds are *not* taken off but slide out on studs—affording room to *lift out* valves as complete units. Packing is easily renewed—note accessibility of stuffing boxes.

☐ **Interchangeable wearing parts**—available among 3, 5, 7 and 9 plunger pumps of same stroke size. This minimizes spare parts costs and inventories.

☐ **Changeable plunger sizes**—in many cases it is only necessary to add new plungers, glands, throat bushings and packing *to the same fluid-end.*

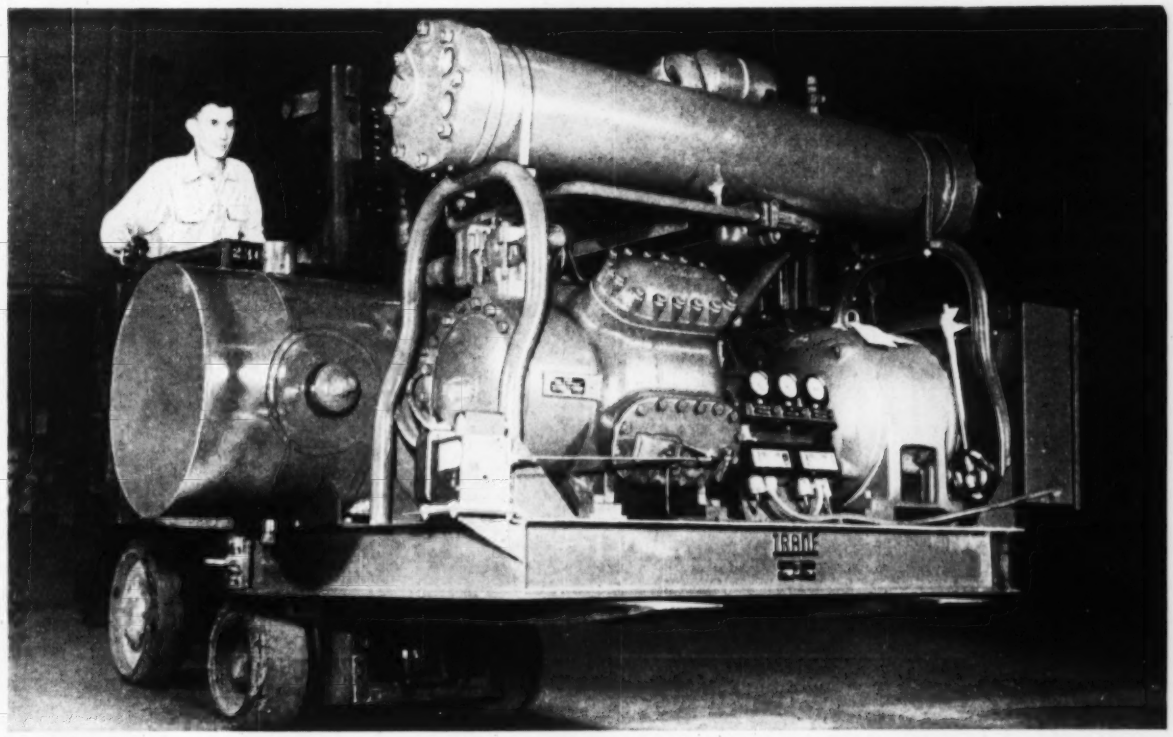
☐ **Drive direct**—by connection to synchronous engine type motor or internal combustion engine; also with integral speed reducer or V-belts.

Contact your Aldrich Representative . . . or write to us direct for complete details on 3", 5" or 6" stroke units.

**THE ALDRICH PUMP COMPANY**
**29 PINE STREET • ALLENTOWN, PENNSYLVANIA**

*. . . Originators of the Direct Flow Pump*

Representatives: Birmingham • Bolivar, N. Y. • Boston • Buffalo • Carmi, Illinois • Charleston, W. Va. • Chicago • Cincinnati • Cleveland • Dallas • Denver • Detroit • Duluth Houston • Los Angeles • New York • Oakland, Calif. • Philadelphia • Pittsburgh • Portland, Ore. • Richmond, Va. • Rochester • Salt Lake City • San Francisco • Seattle Somerville, Mass. • Spokane, Wash. • Syracuse • Tulsa • Washington, D. C. • Youngstown • Export: Petroleum Machinery Corp., 30 Rockefeller Plaza, New York 20, N. Y.



**Ready to install** . . . the new TRANE Cold Generator is a complete mechanical refrigeration machine for producing chilled water. Wired, piped, refrigerant-charged. All interconnected for immediate process cooling or comfort air conditioning applications. Ten sizes, 10 to 100 tons. 25 h. p. unit illustrated. For jobs larger than 100 tons, see CenTraVac below.

# New Trane packaged water chiller comes ready to run!

## *It's wired, piped, refrigerant-charged at the Trane factory!*

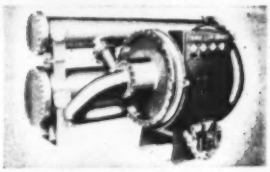
**A quick, low-cost source of process cooling.** Now you can have chilled water from a single packaged unit at the temperature exactly right for air conditioning . . . or for electroplating, metal quenching, die cooling, rubber mixing, brewing . . . almost any industrial process.

**Ready to run.** Here's what you get in this one compact, ready-to-run assembly: Compressor and motor, condenser, insulated dry expansion chiller, insulated heat exchanger, refrigerant piping, safety valves, wiring and automatic controls for full or partial load operation. Everything is there . . . carefully engineered, exactly matched, completely assembled. Ready to run as soon as simple plumbing and electrical hook-ups are made.

**Rugged, easy to relocate.** The TRANE Cold Generator is no fragile piece of equipment. It's designed for rugged factory use. Machine vibrations won't affect its smooth operation. And since it is so compact and requires no special base, it can be quickly moved to new locations when necessary. The average-size unit can be lifted with a fork-lift truck.

**Now—accurate control!** The Cold Generator makes precise temperature control a factor you can depend upon. No guesswork. You know that the temperature for your particular operation will be delivered exactly as required.

Get all the facts. Contact your nearest TRANE Sales Office or write TRANE, La Crosse, Wisconsin, for Cold Generator application and performance data.



**For larger jobs,** select the TRANE CenTraVac. This hermetic centrifugal refrigeration unit provides 45 to 400 tons of refrigeration. Self-contained, completely automatic.

**TRANE Climate Changers** heat, cool, humidify, dehumidify, filter and circulate air . . . singly or in combination for comfort or process applications. Capacity from 450 to 22,000 cfm.

# TRANE

## COLD GENERATOR

***brings you process cooling in a package!***

MANUFACTURING ENGINEERS OF AIR CONDITIONING, HEATING AND VENTILATING EQUIPMENT

The Trane Company, La Crosse, Wis. • East. Mfg. Div., Scranton, Penn. • Trane Co. of Canada, Ltd., Toronto • 87 U. S. and 14 Canadian Offices.

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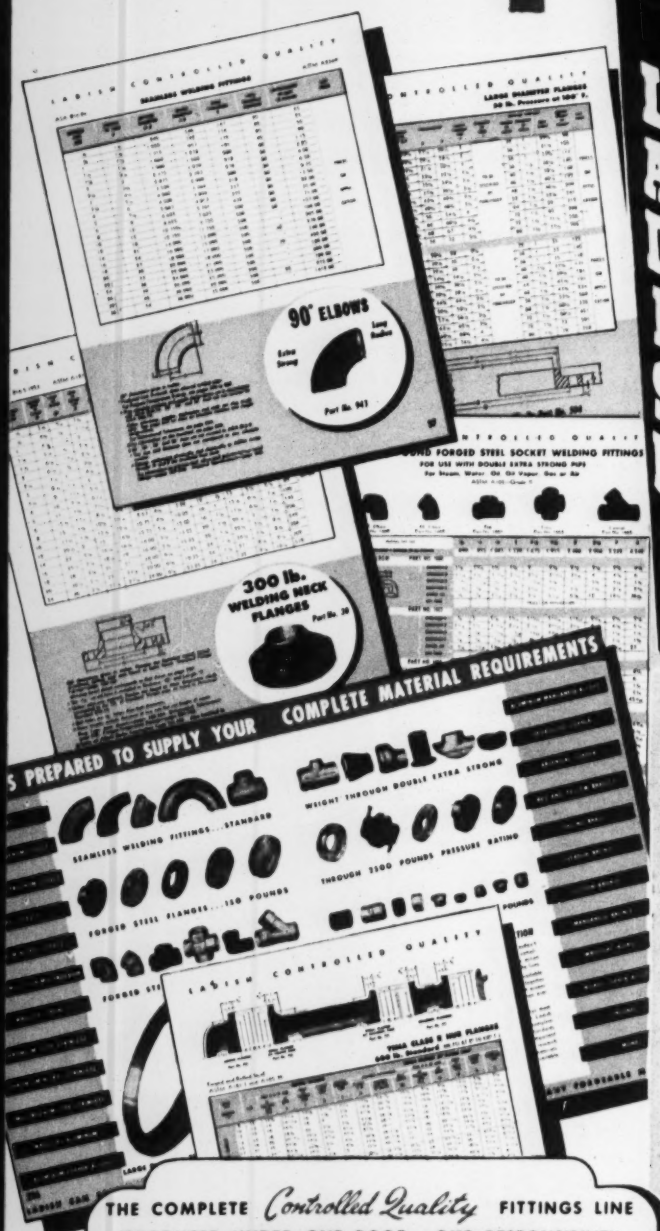


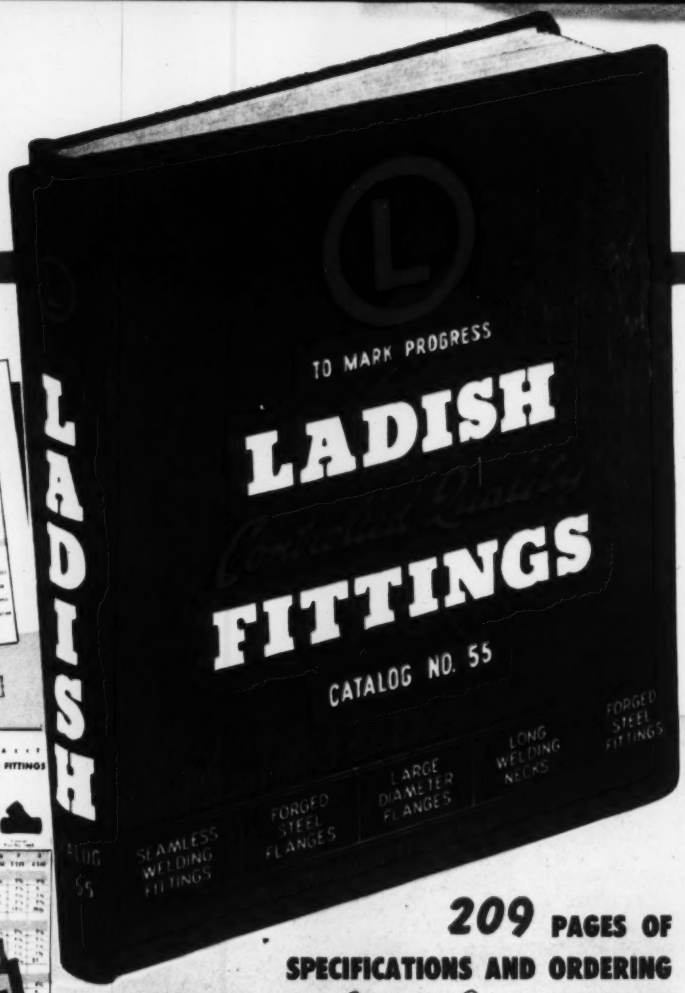


## 209 PAGES OF SPECIFICATIONS AND ORDERING INFORMATION ON *Controlled Quality* FITTINGS

**Here are detailed dimensions, weights and specifications to assist in selecting proper fittings for any application. Featured are a number of Ladish developments which improve piping efficiency. Major product listings by sections include:**

**68 PAGES BUTT WELDING FITTINGS**
Available in Standard through Double Extra Strong weights... in sizes ½ through 42 inches.

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Available in 150 through 2500-pound pressure ratings ... in sizes ½ through 24 inches.

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Available in a complete range of types and pressure ratings... in sizes up to 160 inches in diameter.

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Available in 150 through 2500-pound pressure ratings ... in sizes from 1 through 24 inches.

**5 PAGES FORGED WELDLESS ROLLED RINGS**
Available in diameters up to 240 inches in a wide variety of forged contours...in weights up to 40,000 pounds.

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Screwed and Socket-Welding types in 2000 through 6000-pound pressures, sizes ⅛ through 4 inches.

**12 PAGES STAINLESS AND ALLOY FITTINGS**
Featuring data on properties of materials and a comprehensive table of piping specifications.

THE COMPLETE *Controlled Quality* FITTINGS LINE
PRODUCED UNDER ONE ROOF...ONE RESPONSIBILITY

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# New LADISH Catalog

## Provides detailed specifications on complete fittings line plus useful technical data to help solve piping problems

New from cover to cover and thoroughly up to date in latest provisions of codes and standards—this catalog presents a line broad and completely integrated in types, sizes, ratings and materials.

Easy to use . . . for it is fully tabbed with each section having its own pictorial index and table of contents. Durably bound, this book is a reference work on forged and seamless welding pipe fittings and flanges.

### 56 PAGES OF TECHNICAL DATA WITH LATEST CODE PROVISIONS SIMPLIFY DESIGN PROBLEMS

For busy engineers here are tabulations of pre-calculated values derived from frequently used design formulae which can be applied directly to the solution of piping problems with a minimum of computations. In addition to data on dimensional tolerances, friction loss and material specifications, this section contains valuable tables on:

#### ALLOWABLE STRESS AND P/S VALUES

Presented here in an easy to use form, these values help solve problems of wall thickness and working pressures in gas, power, district heating, refrigeration, oil transmission and refinery piping.

#### MAXIMUM WORKING PRESSURES

Tabulations for ½ through 30-inch pipe in a wide selection of wall thicknesses and materials for operating temperatures from 100° F. through 1500° F., in power, district heating, oil transmission, refinery and gas piping systems.

#### FLANGE PRESSURE-TEMPERATURE RATINGS

Tabulations feature new ratings for a wide range of materials for temperatures from 100° F. through 1500° F.

#### PROPERTIES OF PIPE

Dimensional characteristics of carbon, alloy and stainless steel pipe in commonly used nominal sizes and wall thicknesses to help solve problems of anchorage, heat loss and insulation.

#### FLOW THROUGH ORIFICES AND NOZZLES

Discharge through orifices, nozzles and short tubes are tabulated for a wide range of pressures up to 5000 P.S.I. and diameters from 1/64 through 1¼ inches.

LADISH CONTROLLED QUALITY
Pressure Temperature Ratings for Ladish Forged Carbon and Alloy Steel Pipe Flanges
LADISH CONTROLLED QUALITY
FLOW THROUGH ORIFICES, NOZZLES AND SHORT TUBES
LADISH CONTROLLED QUALITY
LADISH CONTROLLED QUALITY
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LADISH CO.
Dept. ME, Cudahy, Wisconsin

Please send me, without cost or obligation, the new 304-page Ladish Fittings Catalog No. 55.

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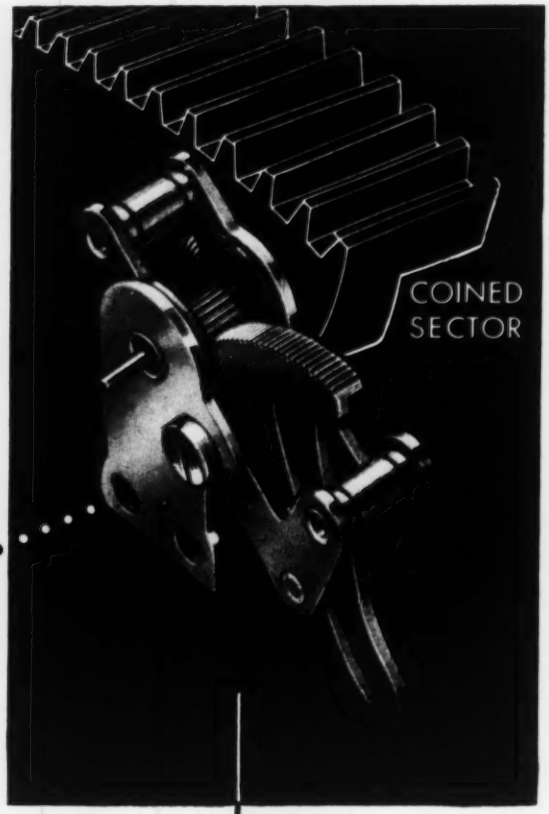
*...for the world's finest gauge:*

# . . . the world's finest movement



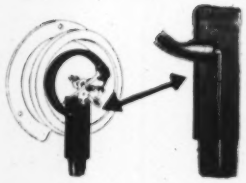

To actually become the standard of comparison in its field, a product must be better; not just in some ways, but in *all* ways.

A particularly good example of such a product is the Marsh Master-gauge. By giving industry a gauge that is better in *all* ways, it has become the recognized standard of comparison in the pressure gauge field.

The movement illustrated here represents just one way—but a very important way—in which the Mastergauge excels. In a pressure gauge, the movement has the vital assignment of converting the action of the bourdon tube into accurate pressure indication. To do this unfailingly, a movement must be ruggedly constructed, practically frictionless and highly resistant to corrosion.

All of these attributes are ideally combined in the Master gauge movement. A self-lubricating, frictionless effect is achieved by using alternate stainless steel and monel throughout . . . gears, hardened stainless; bushings, "K" monel, and so on through all moving parts. A particularly outstanding feature contributing lasting accuracy is the "coined" sector gear. Note the broad face which results from this coined extrusion of the gear blank.

Yes, features like these, along with precision machining, painstaking assembly, and thoroughgoing testing, makes a better-in-all-ways movement for a better-in-all-ways gauge. Ask for up-to-the-minute information.



**A better tube construction...**

***"Connoweld"*** A truly revolutionary development is the joining of the socket, bourdon tube, and end-piece into a one-piece unit in the Marsh Mastergauge. The photo of a socket cut in half shows the perfect fusion at the point where too many gauges leak. A special Marsh process — the Connoweld Process — makes this possible.

**A better Case . . .**

***"Marshalloy"*** Another recent development that has increased Mastergauge leadership is the copper-clad, wrought steel case. Copper surfaced by the Marsh-developed "Marshalloy" process, the case is attractive and noncorrosive. It is four times as strong and one-third lighter than conventional cast iron case!

**MARSH INSTRUMENT CO.,** *Sales affiliate of Jas. P. Marsh Corporation*
**Dept. 29, Skokie, Illinois**
**Export Dept., 3501 Howard St., Skokie, Ill.**

# MARSH GAUGES

"THE STANDARD OF ACCURACY"

**Thermometers • Water Regulating Valves • Solenoid Valves • Heating Specialties**

U.S. Army Photograph

# Quick on the bull's-eye and stay there

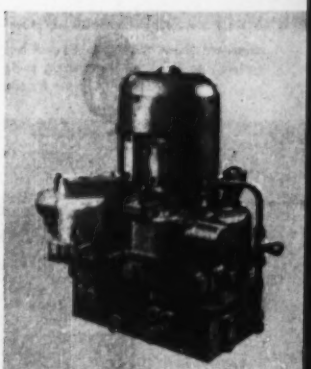
## WITH OILGEAR FLUID POWER

**Meeting speed, control and precise performance requirements of today's U. S. Tanks, Howitzers and Anti-Aircraft Guns is a "Natural" for Oilgear ANY-SPEED Fluid Power Components.**

Gunners in Sherman, Pershing and Patton tanks experienced the advantages of rapid fluid power slewing and precise fluid power tracking of the turret and gun 360° in either direction. They appreciated the value of Oilgear fluid power that obeyed a light twist of the wrist. Likewise, those manning America's most effective 40 mm anti-aircraft guns, recognized the importance of automatic, self-synchronizing Oilgear fluid power drives for rapid slewing and precise tracking of the carriage 360° in either direction and the rapid, accurate elevating and depressing of the gun for quick homing on the target and following it.

Therefore, when today's new combat vehicles with far greater fire power and accuracy were planned, Oilgear ANY-SPEED Fluid Power Drives were a "Natural" for both turret traverse and gun elevation. They met the demands for accurate control over speed ranges up to 4000:1. They provided unbelievably low tracking speeds under precise response without overrun or drift. They stayed on the target for repetitive shots. No wonder, one men's magazine calls the new Oilgear equipped M47 "the sharpest shooting tank anywhere today." That's why Oilgear ANY-SPEED fluid power drives are a "Natural" on the wide variety of U. S. combat vehicles.

Don't you think it is time for you to look with wide open eyes at Oilgear Fluid Power Pumps, Motors and Transmissions for your machines... to better the performance of an already good machine? To solve a seemingly "impossible" design problem? To synchronize machine units easily and economically? To weed out trouble and cut maintenance and down time to a surprisingly low level? Counsel with an Oilgear Engineering Representative will cost you nothing, may benefit you greatly. THE OILGEAR COMPANY, 1570 W. Pierce St., Milwaukee 4, Wisconsin.



**OILGEAR POWER PACK**

Self-contained unit used in present day tanks and howitzers. Consists of electric drive motor, two Oilgear two-way variable delivery pumps (or generators), oil reservoir and integral closed system controls for turret traverse and gun elevation. Supplies fluid power to Oilgear hydraulic drive motors.

OILGEAR

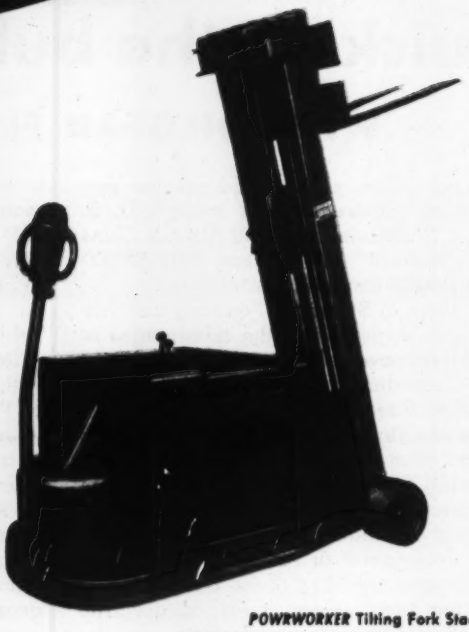
**OILGEAR**

# Announcing the

## Feature by feature,

***POWRWORKER*** **"26" Pallet Truck**
**4000 and 6000 lbs. capacity**

***POWRWORKER*** **"26" Platform Truck**
**4000 and 6000 lbs. capacity**



***POWRWORKER*** **Tilting Fork Stacker**
**1500, 2000, 2500 and 3000 lbs. capacity**

# POWRWORKER "26"

## It's engineered to meet your own handling requirements

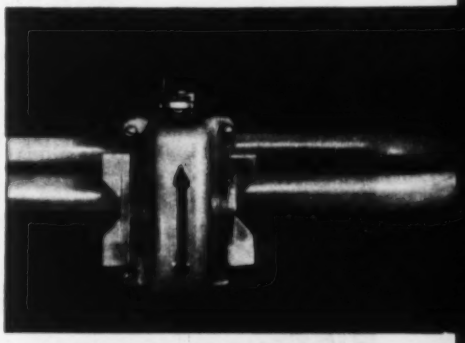
Here's a line of electric trucks designed and engineered with the *user* in mind . . . the 1954 POWRWORKERS. Detailed job-studies in customer plants, warehouses and terminals, dictated the features of the POWRWORKER "26". No truck on the market today can equal the combination of *user-benefits* which the POWRWORKER "26" provides:

- **Maximum Maneuverability**—Only 26" maximum lost length (the truck is only 26" longer than the load), the shortest standard truck on the market.
- **Light Weight**—Minimum overall weight is maintained by complete fabrication, providing maximum strength for the toughest jobs.
- **Stability**—All operating units, including battery, are mounted in an underslung position close to the floor, providing a low center of gravity for load stability.
- **Great Efficiency**—A double reduction of spur gears transmits power from the motor to the driving axle—maximum ton-miles at minimum power cost.
- **Balanced Load Distribution**—Double lifting cylinders uniformly distribute load for smooth, easy lifting and lowering.
- **Safety**—Protective guard for operator protection, either walking or riding. Deadman switch cuts power when brake is applied and handle returns to vertical position when released by operator.
- **Easy to service**—All operating units are readily available without getting under or dismantling the truck—maximum accessibility. The standard drive wheel tire is quickly demountable.

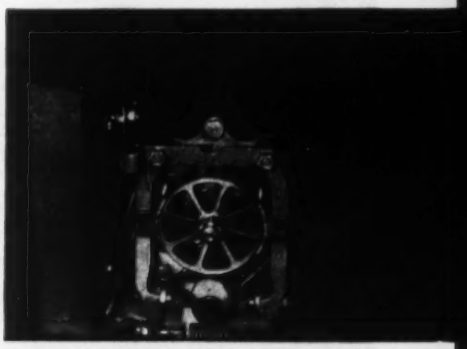
We invite you to compare the 1954 POWRWORKER with any truck on the market. Feature by feature, it's engineered for lowest-cost handling, long-life under tough working conditions. It's easy on the operator, easy on the maintenance man.

For details on the POWRWORKER "26"—the one electric truck built to *your* specifications—call your local Clark dealer, listed in the Yellow Pages of your phone book. Or simply send in the coupon for descriptive literature.

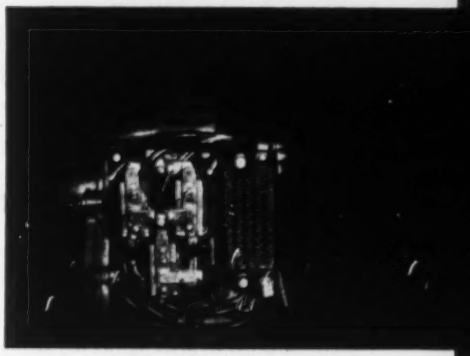
**The *POWRWORKER* "26" is at your disposal under Clark's Pay-As-You-Go lease plan. Ask your Clark dealer about this low-cost leasing plan.**



Simplified travel controls for two speeds in either direction with operator protection.



Positive spring-applied brake on motor shaft transmits braking force through a gear ratio of 22-1 to driving wheel. Safety with smooth performance.



Control panel is mounted on the power head, sealed in a dust tight box—no long flexing wires or current collectors—all contractors have silver-to-silver contacts for long life.

CLARK EQUIPMENT

POWRWORKER SECTION
Industrial Truck Division
CLARK EQUIPMENT COMPANY
Battle Creek 88, Michigan

☐ Please send POWRWORKER literature.
☐ Have representative call.

Name_____

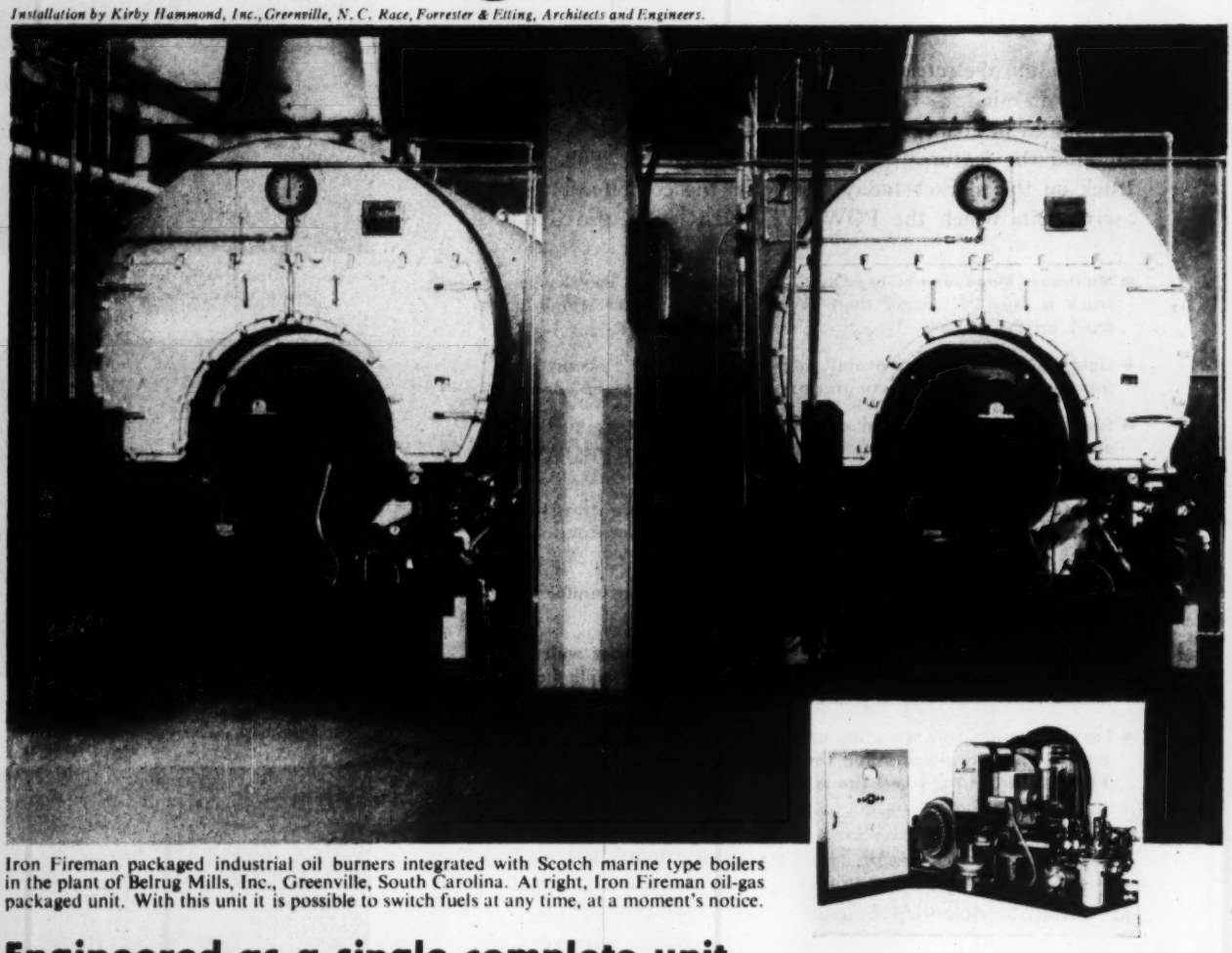
Firm Name_____

Street_____

City_____ Zone_____ State_____

# "Packaged" for better firing at lower cost

*Installation by Kirby Hammond, Inc., Greenville, N. C. Race, Forrester & Etting, Architects and Engineers.*



Iron Fireman packaged industrial oil burners integrated with Scotch marine type boilers in the plant of Belrug Mills, Inc., Greenville, South Carolina. At right, Iron Fireman oil-gas packaged unit. With this unit it is possible to switch fuels at any time, at a moment's notice.

## Engineered as a single complete unit

This Iron Fireman package unit is much more than a conversion burner. It's a complete combustion system in which all elements are correctly balanced and integrated—a thoroughly engineered firing plant. It includes burner (for oil or gas or both), fuel system, forced draft air supply, control panel, and pre-formed refractory combustion throat. Installation requires little more than bolting the entire unit to the boiler front and making service connections for power and fuel.

To the user this means an attractive saving in installation time and cost. But even more important, it means a factory assembled and tested unit instead of a locally assembled job. It means dependable performance and high operating efficiency, with substantial fuel savings. It's the *smart* way to modernize your boiler room.

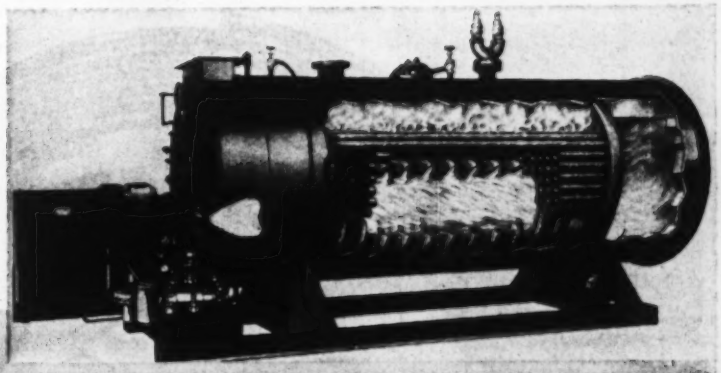
Get in touch with your Iron Fireman dealer, or mail the coupon on the opposite page for complete information.

THE IRON FIREMAN

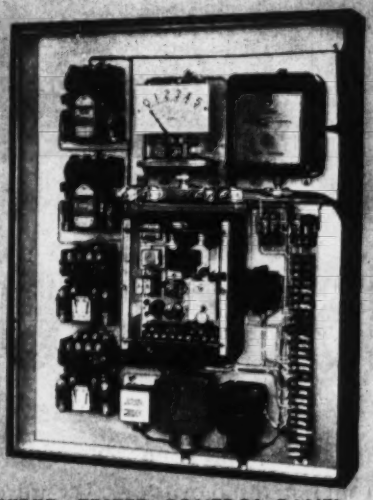
® Iron

OIL, GAS AND COAL FIRING

# OIL, GAS or OIL-GAS COMBINATION BURNER UNIT BY IRON FIREMAN



Cutaway view of packaged boiler-burner unit consisting of Scotch marine boiler with Iron Fireman combination Gas-Oil forced draft burner. The shift from one fuel to another is accomplished quickly, with no sacrifice in firing efficiency.



**WIRED, TESTED CONTROL PANEL**

Control panel is totally enclosed, with all instruments wired and tested at the factory. Entire wiring system is coded, with varicolored wires and numbered terminal strip inside panel. An indicating meter on the panel door shows the condition of the control system at all times. Indicating lights on panel front show operating status of unit at a glance. Green lights show motors in service; red indicates safety lockout.

**IRON FIREMAN ROTARY OIL BURNER**

The oil firing unit is the Iron Fireman rotary cup oil burner which has an outstanding record of reliability in precision firing of hard-to-handle heavy oils. Heart of the oil control system is the Iron Fireman Oil Volumeter, a variable volume metering pump submerged in the oil reservoir, which delivers the correct volume of oil to the burner head with extreme accuracy, regardless of changes in oil viscosity. Burns any grade of oil, from lightest to heaviest, without special adjustment.

**REFRACTORY COMBUSTION THROAT**

The combustion throat, with preformed built-in refractory, is an integral part of the burner unit. Both primary and secondary air are admitted to the combustion chamber through this throat, eliminating the special brickwork required by the usual conversion burner and greatly improving the air-fuel mixture. Oil cup is in the center of the refractory disc, which also shields the gas jets against the radiant heat of the furnace. Adjustable inlet vanes control the shape and rotation of the flame to match the requirements of the firebox or firetube.

## No divided responsibility

No separate contracts for (1) boiler setting (2) electrical wiring (3) oil heating equipment (4) automatic control system (5) forced draft system (6) boiler refractory.

You can install a complete new boiler plant quickly and economically by specifying an Iron Fireman packaged burner and a Scotch marine type boiler engineered specifically for use with this unit. Forced draft, no high stack required. Or you can install the Iron Fireman packaged burner in practically any type of existing boiler, with important savings in installation and operating costs.

## How to specify

First, decide what fuel or fuels you want to use (oil, gas or oil-gas combination). Second, determine the load. Third, refer to table in Iron Fireman catalog or specifications for the correct size of burner and boiler for your job.

For more information use the coupon below.

# Fireman

**FOR HEATING, PROCESSING, POWER**

Iron Fireman Mfg. Co., 3061 West 106th Street, Cleveland 11, Ohio. In Canada, write 80 Ward Street, Toronto, Ontario.

Please send me literature giving full information on the Iron Fireman "packaged burner" unit.

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*Address* _____

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Thus you may build your own clutch or brake from our standard stock Maxitorq parts. The Disc-Pac keys to your shaft and is easily replaced. Units are available in 8-disc diameters from 2″ to 8″; ¼ to 15 h.p. at 100 r.p.m. . . . with 3 lugs on the smallest size, 8 lugs on the 3 h.p., and 12 lugs on the 5, 10 and 15 h.p. capacities.

The Disc-Pac fits Maxitorq standard Driving Rings in the event that you want to use them. As with the Maxitorq Clutch, all assembly, take-apart and adjustments are manual . . . no tools required.

Write Dept. ME-3 for full specifications and quotations.

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**THE CARLYLE JOHNSON MACHINE COMPANY**
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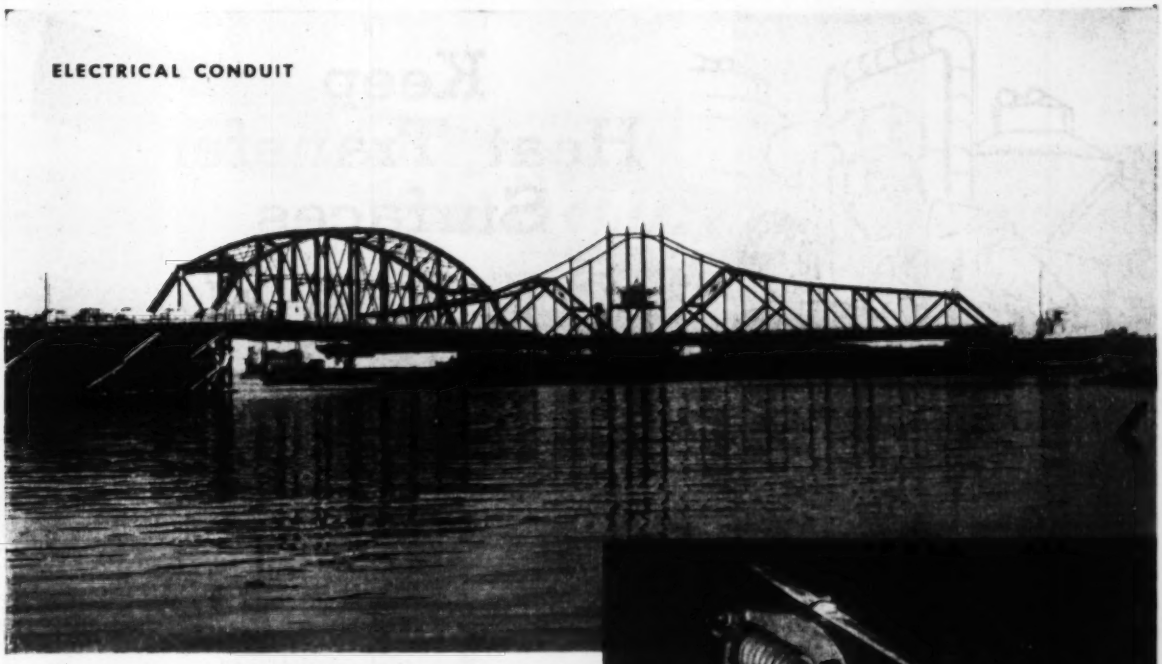
ELECTRICAL CONDUIT



**DULUTH-SUPERIOR BRIDGE** opens from 15 to 50 times daily in the iron ore shipping season to let ore boats through. Wiring for lighting, protected by 1500 feet of Everdur Electrical Conduit, is installed under the deck.

**HERE EVERDUR CONDUIT** protects wiring to electric brakes on bridge motor. It is also used for power lines to emergency generator, and on lines serving strip heaters in power house.

# Everdur passes long test on Duluth-Superior span

One job Everdur* Electrical Conduit does on the Duluth-Superior Bridge is protect electric light lines. Heavy rain and snow driven by 60 to 70 mile-an-hour winds often pound at this conduit. Heat and cold do their worst. It is exposed to acid fumes from ore boats and rail traffic. Vibration from opening and closing of the bridge, and constant traffic, is a daily threat. Yet recent inspection shows the Everdur Rigid Conduit still in excellent condition. Not a sign of wear, rust or corrosion!

Everdur Electrical Conduit is made of Everdur Copper-Silicon Alloy in two wall thicknesses (R.C. and E.M.T.). For additional information about this Anaconda Product, write to: *The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.*

*Reg. U. S. Pat. Off. 53150

***wherever corrosion resistance counts*—EVERDUR ELECTRICAL CONDUIT**

**an ANACONDA® product**

# Keep Heat Transfer Surfaces CLEAN...

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## SCRAPED SURFACE *Exchangers*

IF you are all "gummed up" with a tough heat transfer problem, Vogt Scraped Surface Exchangers will provide the answer. They have patented scraper elements which prevent fouling of the heat transfer surfaces and insure the highest rate of heat exchange between the product and the cooling or heating medium. The scrapers also continuously agitate the fluid and assist removal of solids from the unit.

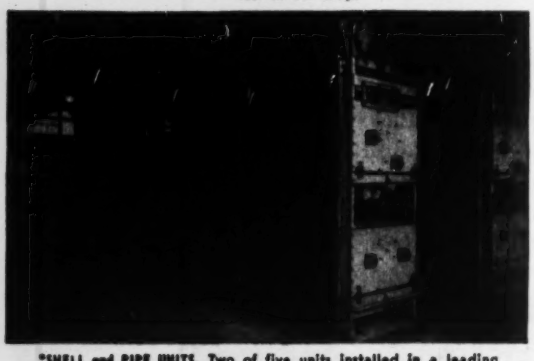
**DOUBLE PIPE EQUIPMENT** is available in two types; EXCHANGERS, for cooling with water, brine, and cold filtrate, and for heating with steam or hot liquids; and CHILLERS, for use with volatile refrigerants such as ammonia, propane, and Freon. Both types have 8" jacket pipes and 6" inner pipes with scrapers.

**SHELL AND PIPE TYPE UNITS** are designed for use with volatile refrigerants and for heating fluids with steam or similar heating mediums. They consist of large welded shells each containing seven 6" scraped pipe sections.

Vogt Scraped Surface Exchangers serve profitably as oil chillers, crystallizers, and heaters in many processes in the petroleum and chemical industries. Their application to your heat transfer problems will receive the prompt attention of our Engineering staff.

*Write for Bulletin PE-1*

*DOUBLE PIPE UNIT. Drive and close-up of 12 section unit under test in our shop.



*SHELL and PIPE UNITS. Two of five units installed in a leading petroleum refinery.

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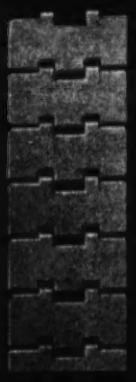

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## For the new pneumatic instrumentation

# Cabled Tube

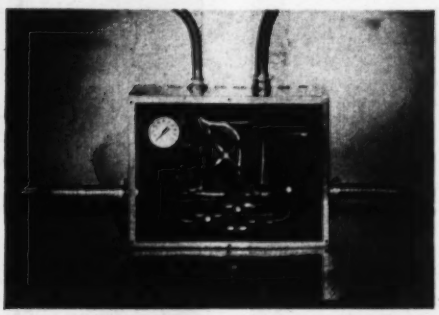
The recent tremendous increase in the use of tube instead of wires for instrumentation and control purposes has led to an important new development—cabled tube. This is an armored group of long tubes twisted together to permit bending without distortion. An insulating tape is wrapped over the bundle of tubes to prevent electrolytic action. Then interlocking, flexible galvanized steel armor is applied, like BX. This protects the tubes from injury during shipment, storage, installation, and in service. Standard fittings, boxes and cabinets can be used for junction boxes and terminations. To make it possible to readily identify each tube, one tube in each layer is colored; the position of each tube in each layer in relation to the coded tube

remains the same throughout the length of the cable.

The tubes usually are copper, but aluminum tubes can be used for special purposes. For unusually corrosive situations, a plastic outer sheath can be applied. As many as 19 tubes, ¼" OD, can be cabled, and supplied in lengths up to 1,000 ft.

Showing the construction of Crescent Armored Multitube, made by Crescent Insulated Wire and Cable Co., Trenton 5, N. J., which will supply further information on request.

Since the tubes carry not electricity but air, nitrogen, helium, or a fluid, they are especially attractive in potentially explosive locations, as in refineries and chemical plants. Utilities are also turning decisively to this new cable, while automatic process control (automation) is a rising application.



Revere, as a supplier of tube for this purpose, calls this cabled tube development to your attention as a matter of general and perhaps specific interest. See Revere for copper, aluminum and brass tube and pipe, electric welded steel tube, and lockseam tube. Call the nearest Sales Office.

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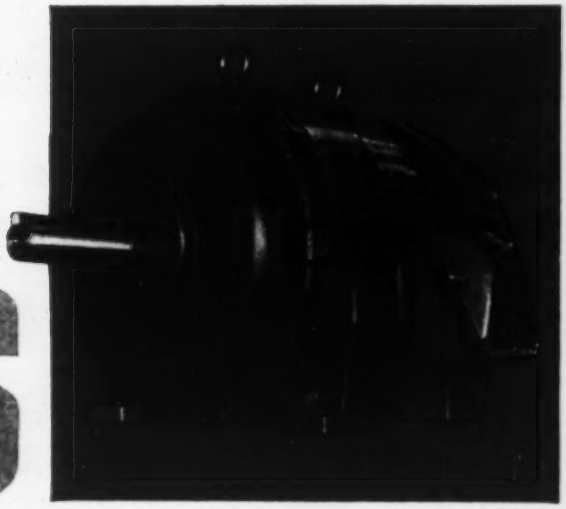
# "ALL MOTORS ARE NOT ALIKE!"



**FOR RUGGED SERVICE,** Reliance Motors are built better to last longer. These *Precision-Built* Motors combine maximum strength with shock-resistant frame and bearing-bracket construction. Write for Bulletin B-2101.

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B-1470

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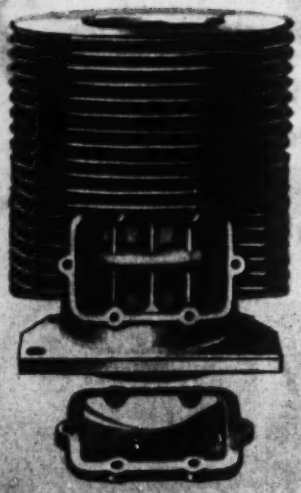
# Lightweight, Strong PARKER Die Castings Reduce Costs on POULAN CHAIN SAW!



THE versatile, rugged Poulan Chain Saw is a boon to woodsmen everywhere. Its portability and ease of handling have made it a profitable piece of equipment to those engaged in the lumbering industry. Lightweight, strong die castings by Parker serve to lighten the load of the operator. The die cast engine cylinder and cover have helped reduce production costs since machining of the die cast part is eliminated. The die cast fins on the cylinder wall are strong and clean, diffusing heat evenly. This is another of the hundreds of instances where Parker Die Castings have lowered costs for manufacturers in nearly every industry. Parker Die Castings are lightweight, strong and clean. Machining is virtually eliminated. Consult with Parker on your next die casting requirements.

*and when you think of Die Castings* THINK OF

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# PARKER ALUMINUM *and* ZINC *Die Castings*

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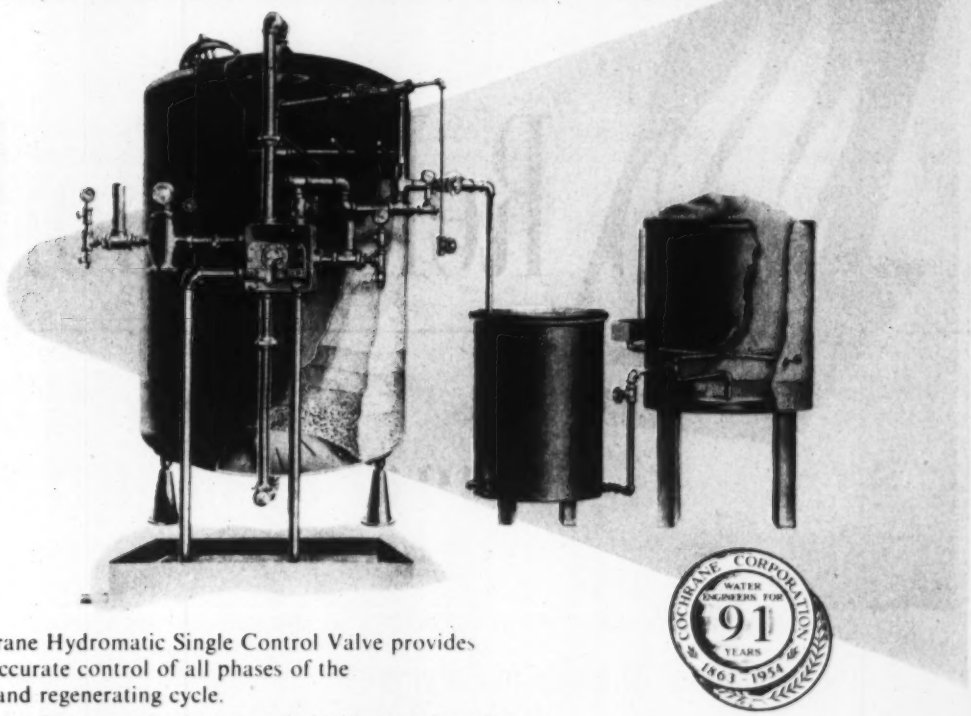
## Cochrane ZEOLITE SOFTENERS

### provide easy, economical operation



The Cochrane Hydromatic Single Control Valve provides positive, accurate control of all phases of the softening and regenerating cycle.

It is so simple to operate that no technical knowledge of the softening process or the equipment is required. High quality effluent is thus assured at a minimum cost and maximum delivery.

Cochrane's 91 years of water conditioning leadership and its complete line of equipment assures you unbiased recommendations for equipment to performance requirements. For the right answer to your water problem, call a Cochrane Engineer today.

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# significant statistics of

# Reheat Boilers

## for period 1947 through 1953

| | |
|---|---|
| Number of Units Ordered | 136 |
| Number of Units in Service | 60 |
| Total Capacity—KW | 15,750,000 |
| Capacity in Service—KW | 5,755,000 |
| Capacity—Controlled Circulation Reheat Boilers—KW | 6,260,000 |
| Capacity fired by Tilting Tangential Burners—KW | 14,380,000 |

B-641A

**COMBUSTION** **ENGINEERING**

Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.

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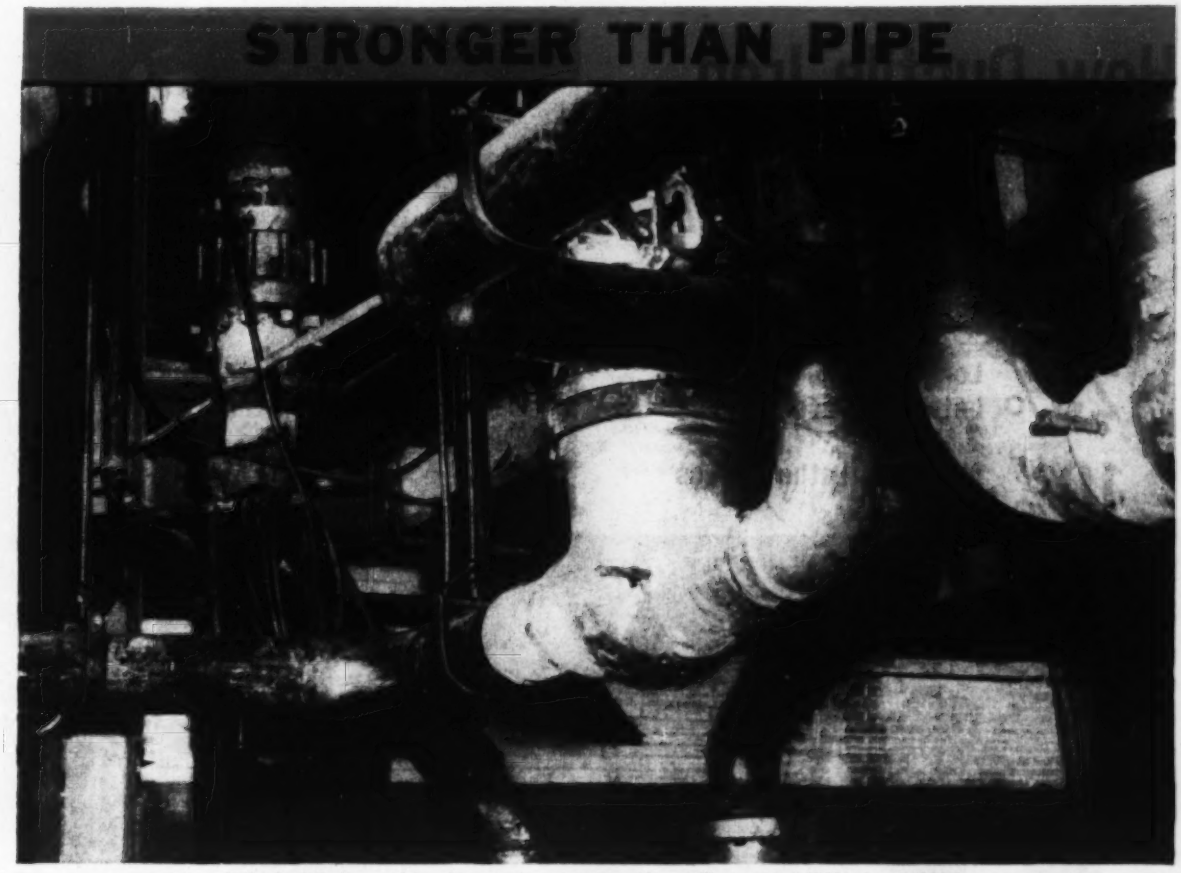



Boiler feed discharge piping shown under construction above will operate at 2700 psi and 430° F.

# Grinnell Welding Fittings

## exceed bursting strength of seamless pipe

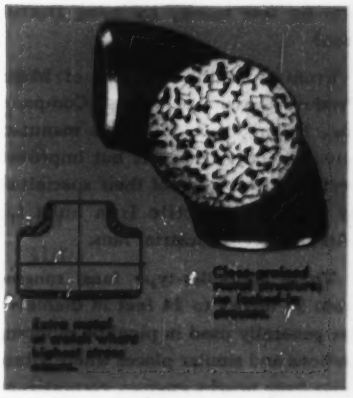
Grinnell Welding Fittings are designed and processed to have a bursting strength greater than the calculated bursting strength of the seamless pipe to which they are to be welded.

Welding elbows and bends are made from seamless steel pipe by a forging process which produces uniform wall thickness at all points; there is no thinning of outer wall.

Welding tees and crosses are made from seamless pipe by a drawing process which provides extra metal and protection at the crotch, where highest stress occurs.

All Grinnell Welding Fittings are process stress-relieved, thus improving grain structure and increasing the strength of the metal.

With all Grinnell Welding Fittings, you get true circularity; smooth, clean inside surface; full, effective radius; easy, sweeping turns; accurate bevels; and true included angles. Available in a wide range of types and sizes, metals and alloys. Send for descriptive catalog.



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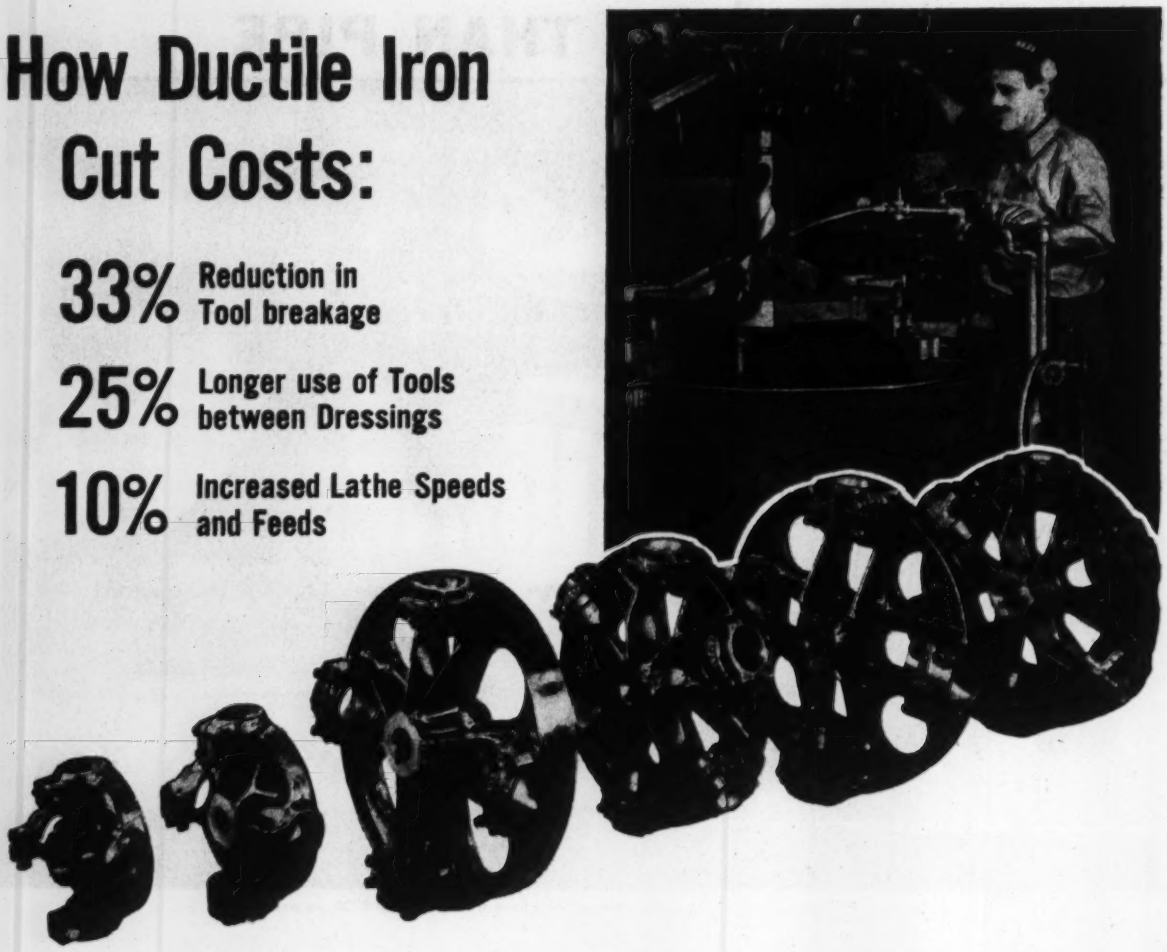
# How Ductile Iron Cut Costs:

**33%** Reduction in Tool breakage

**25%** Longer use of Tools between Dressings

**10%** Increased Lathe Speeds and Feeds



Who will be next to make better products for less money by using Ductile Iron?

Profit from the example of Metal Products Division of Koppers Company, Inc., Baltimore 3, Md. This manufacturer not only cut costs but improved performance of one of their specialties by adopting Ductile Iron hubs for "Aeromaster" industrial fans.

These propeller-type fans, ranging from 54 inches to 24 feet in diameter, are generally used in pipeline pumping stations and similar places where vibrations from nearby engines, compressors or other machinery compound the vibrations of a fan.

INCO

For the hubs, which may vary from 50 to 225 pounds in weight, good tensile and fatigue properties are obviously essential. In addition, excellent castability is needed because the heavy center portion, the heavy flange and the thin inter-connecting webs of each hub vary considerably in section thickness.

So far, no Ductile Iron hub has been rejected. The manufacturer sand-blasts hub castings and then heat-treats to provide 60,000 p.s.i. minimum tensile strength and 15% elongation.

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Send us details of your prospective uses, so that we may offer a list of sources from some 100 authorized foundries now producing Ductile Iron under patent licenses. Request a list of available publications on Ductile Iron... mail the coupon now.

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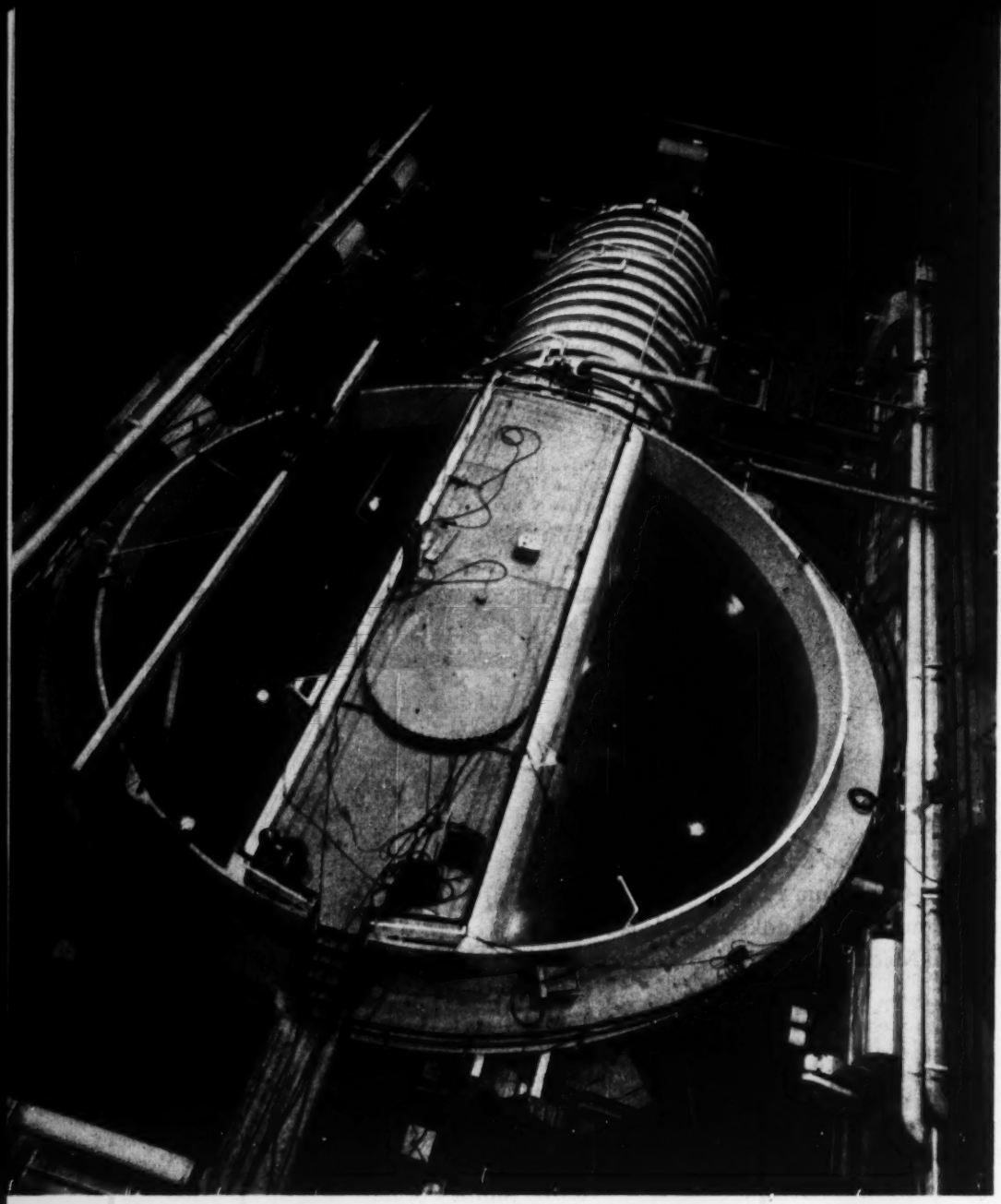

## First atomic submarine engine, Mark I ...

... contained in the land-based submarine hull at the submarine thermal reactor site at the National Reactor Testing Station, Idaho, is a near duplicate of Mark II which will drive the U. S. S. *Nautilus*. The large sea tank is about 50 ft in diam and almost 40 ft high. The hull passes through the tank so that the reactor compartment is located within the tank and completely submerged in water. The tank's capacity is about 385,000 gal. Both plants were built by Westinghouse Electric Corporation under contract with the Atomic Energy Commission. For further details see "Atomic Submarine Launched," on page 264 of this issue.

# *Editorial*

MECHANICAL ENGINEERING

March 1954, Vol. 76, No. 3 . George A. Stetson, *Editor*

## A Window on Europe

In the addition of J. Foster Petree of England to its editorial staff as a "foreign correspondent," Mechanical Engineering is partially fulfilling the oft-repeated desire of many of its readers for an expansion of the space devoted to short readable notes on engineering events and achievements originating in sources other than papers presented at ASME meetings or in other ASME activities. The new section of this magazine, containing material prepared by Mr. Petree, makes its first appearance this month and will be found on pages 276 and 277.

Mr. Petree is well known to many ASME members. From March 1, 1939, to Dec. 31, 1953, he was editor of *Engineering*, a magazine widely read in this country and all over the world. In 1953 Mr. Petree spent considerable time in the United States. He delivered the Calvin W. Rice lecture at the 1953 ASME Fall Meeting in Rochester, and the text of that lecture was printed in the December, 1953, issue of this magazine under the title "Position of the Technical Press in Relation to Industry." He is a member of this Society and of several others in the British Isles. His activities afford him opportunity for first-hand contacts with and observations on engineering developments in the British Isles and Western Europe, which will provide subject matter for his monthly feature.

Engineering, like the arts and sciences, is not confined within national boundaries except in relatively few cases where secrecy is essential to security. From the early days of the Society, engineers from other nations have contributed papers and discussions of papers for ASME meetings and publications. They have been accepted as members and many have been elected to Honorary Membership. Cordial relations exist between ASME and the engineering societies of the free world. International meetings are held, as witness the ASME 1954 Spring Meeting this month in Mexico City and several meetings in Canada in recent years. At the 1953 ASME Annual Meeting 8 of the 16 papers constituting the Frequency-Response Symposium were written by engineers residing overseas and all but one of these papers were presented by their authors in person. ASME joins with societies of other countries in such bodies as ECPD, EUSEC, and UPADI, and in international conferences such as CIOS and the World Power Conference. ASME Transactions are to be found in depository libraries all over the world.

By establishing its own observation post in the British Isles and Western Europe, Mechanical Engineering adds a service useful to its readers that is in line with ASME tradition. When the magazine was instituted, one of its features was the Engineering Survey, a department conducted by Leon Cammen, a scientist and engineer, Russian by birth, who had a command of more than a dozen languages. Mr. Cammen translated into English the substance of engineering articles printed in foreign-language technical journals. Later, he expanded the Survey to include abstracts from English-language journals. Upon his death in 1936, the character of the Survey changed because no one could be found who combined a knowledge of foreign languages and a knowledge of scientific and engineering matters. The name of the department was changed to "Briefing the Record," and the character of the material and its treatment were modified to suit the abilities of the editor responsible for compiling it. In recent years, surveys of readers' interests have rated "Briefing the Record" as the most widely read and highly regarded section of the magazine. Suggestions that it be expanded have frequently been made. One obvious direction of expansion was to engage a foreign correspondent and such a step has been under consideration for many years. Hence, when Mr. Petree's services became available immediate steps were taken to secure them.

## Because of Watt

An appeal has been issued "for subscriptions toward the overdue repair and subsequent maintenance of . . . . . the famous James Watt Monument in Greenock, Scotland, birthplace of the genius who first perceived the principles that made the steam engine a revolutionary instrument, whose name has been given to the unit of electrical power the world over." It is directed "not merely to the citizens of Greenock but to all those who have prospered by the inventions of James Watt, and to all who care for the great tradition of precise engineering." The Appeal Fund Committee, under the chairmanship of George Morrison, is located at James Watt Monument, Union St., Greenock.

The famous Watt Monument is a building, begun in 1835 with funds provided by James Watt, Jr., which houses the Greenock library, the oldest subscription library in Scotland, founded in 1753. In 1816 Watt himself sent to the library the sum of £100 "to form the beginning of a scientific library" and expressed the hope

that "the donation will prompt others to add to it, and so render my townsmen as eminent for their knowledge, as they are for their public spirit and enterprise." The books purchased with Watt's donation, and some 60,000 more, still exist in the building set up by the inventor's son in part "to provide a dignified setting for Chantry's statue of the great inventor."

With the development of the steam engine, power sites were no longer confined to rivers and waterfalls, and transportation became independent of beasts of burden and the wind. Machinery which required more than manpower for its operation developed rapidly, with corresponding developments in industry and production per man-hour. Toward the end of the nineteenth century the steam engine was in general use for the driving of electric generators, thus adding greater flexibility, economy, and diversity to the tasks done by means of power, while in transportation and in rural districts particularly, the internal-combustion engine carried the greater share of the power production. And the end is not yet, for today we stand on the threshold of unforeseen developments in nuclear energy. At the close of nearly two centuries since Watt conceived the separate condenser and commenced his remarkable improvements of Newcomen's pumping engine, there are few persons in the Western World who have not prospered because of the results of Watt's work.

## A Task for Youth

On a Sunday afternoon in January, through the medium of television, several hundred thousand persons watched the performance of a shortened version of Shakespeare's play, "King Richard the Second." The events of the play took place toward the end of the fourteenth century and were dramatized some two-hundred years later. The characters were of royal or noble birth, living under a feudal system that was on its way toward collapse. There was talk of the divinity of kings ("God's substitute, His deputy annointed in His sight"), of ruinous taxes, and of oppression of commoner and noble. But a viewer in 1954 got no hint of growing power of the common people and the valiant blows on behalf of freedom that were struck during the fourteenth century. In that century slavery all but disappeared in England as it was discovered that men working for wages were more profitable than bondsmen. The voices of "little people" became articulate in such works as "Piers the Ploughman." John Wyclif had translated the Bible from the Latin into the strong and vigorous language of the laborer and farmer and was turning men's minds toward it as a guide for living. Even the art of war had been revolutionized by the use of the long bow. Thus behind the brilliant pageantry and violent conflicts to resolve personal claims to kingship, two elemental principles were at work out of which material welfare and improvement in the status of the ordinary citizen of the Western world have advanced. For, as Macaulay wrote slightly more than a century ago when the first effects of the Industrial Revolution had made startling changes in life in England: "In every experimental science there is a tendency toward perfection. In every human being there is a wish to ameliorate his own condition. These two principles have often sufficed, even when counteracted by great public calamities and by bad institutions, to carry civilization rapidly forward."

The contrasts which Macaulay noted between the England of his own day and that of 1685 are no less startling than those which we can note between our own times and those of a century ago. Prominent among the influences which have created those contrasts are applied science and the desire of every man to better himself. Today these two influences are increasing in strength as consideration of the contrasts will show. In the Western World they have served to advance the cause of freedom, to increase the abundance and ready availability of the good things of life, and to relieve the minds of the people who enjoy them of the fears and insecurities which threatened the happiness of their forebears.

Spurred by the necessity of survival that recent wars have laid upon us and profiting by the chain reactions set in motion by research and industry, we have achieved miracles in science and in human freedom. Science has been applied not only to the production of things and the extension of our control over the environment in which we live, but to man himself and to his relationships with his fellows. It is being applied also, as the paper, "Operations Research," printed in this issue indicates, to a better understanding and more fruitful achievements of organizations of men and is likely to become a useful tool of management of all manner of enterprises. These two influences, applied science and the desires of men to improve themselves, combined with others which give purpose and direction to human achievement, will create contrasts between the state of civilization today and that of fifty years hence far greater than any noted by Macaulay.

It is the young man who will create these contrasts and enjoy their benefits. Hence it is the young man who should pay particular heed to the great opportunities that lie before him and keep abreast of and understand the current trend of science as applied to production and the management of human institutions. Indeed, in future the grinders shall not "cease because they are few." Production methods, aided by science applied to the work of the world and the management of enterprises, will release more grinders to cultivate the satisfactions that free men rightfully desire.

It is comparatively easy to look backward and recognize the influences let loose by Wyclif, by the abandonment of slavery, by the use of steam power, by the introduction of mass production, or by the application o science to the conquest of disease, to new materials, and to the administration of human institutions. The more difficult task, which lies before the youth of every generation, is to exercise imagination, foresight, and judgment in recognizing similar influences when they first appear, to assess their value, and to assist in their development.

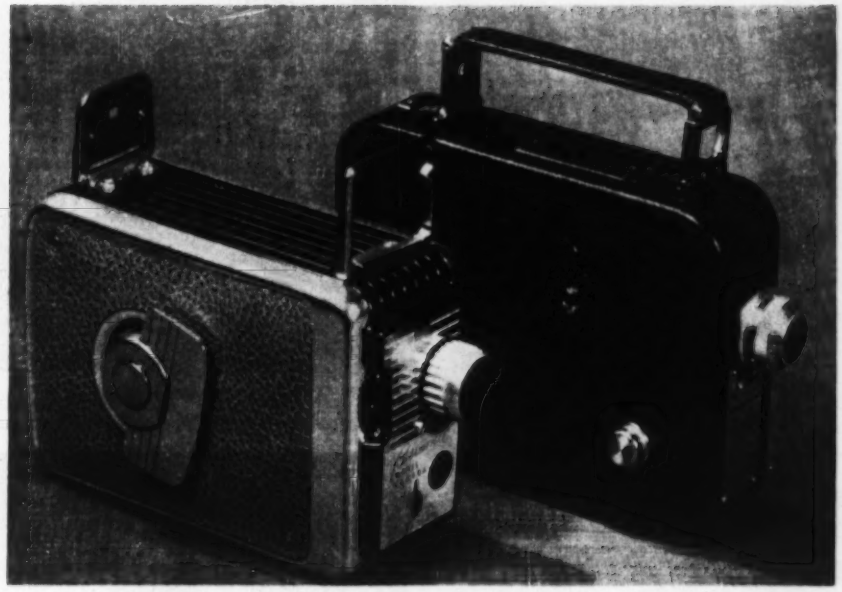

Fig. 1 Over-all appearance of Brownie 8-mm movie camera (left) as compared with Cine Kodak 8-25 camera

# Product Design of the Brownie Movie Camera

How effective production-engineering techniques plus new materials and methods have been incorporated to design an inexpensive movie camera for home use

**By Morris E. Brown**

Supervising Design Engineer, Camera Works, Eastman Kodak Company, Rochester, N. Y.

In 1928 home movies were restricted to those who could afford the price of 16-mm cameras, projectors, and film. It was evident that a large new market could be opened up if the price of all three items could be reduced substantially. This resulted, in 1932 in the introduction of 8-mm home movies. These cameras and projectors were smaller and therefore somewhat less expensive than the 16-mm models. The lenses for both 8-mm cameras and projectors were much less expensive and the film cost was reduced by about 65 per cent.

By 1949 rising costs of materials and labor prompted an investigation of the possible paths open to again lower the cost of home movies. At that time 8-mm Cine Kodak products ranged from $89 to $146, including excise tax, while the major competition priced cameras from $62.50 to $175 including tax.

Contributed by the Production Engineering Division and presented at the Fall Meeting, Rochester, N. Y., October 5–7, 1953, of The American Society of Mechanical Engineers.

## Cost Reduction a Prime Factor

Since it was not considered practical to reduce the film size further, any cost reduction that was to be achieved had to be made in the equipment. Otto Wittel, who has had a hand in the development of nearly all movie cameras designed at Kodak, undertook to meet this challenge. The basic requirements he established were as follows:

1 That the camera be a simple, easy-to-use, 8-mm spool camera.
2 That it be capable of taking top-quality movies.
3 That it include only those features which were required to satisfy the two preceding points.
4 That it be a low-cost mechanism designed for high production volume.

It is important that this last point be firmly established early in the design phase since it is in this phase that all factors including decisions as to materials, methods of

Fig. 2 Mechanism plate assembly of Cine Kodak 8-25

Fig 4 Light-tight cover and case of the Brownie

Fig. 3 Cover and case of Cine Kodak 8-25

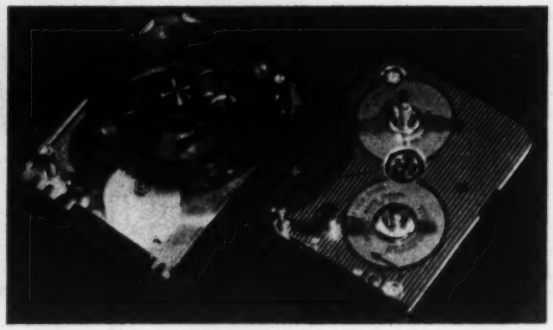

Fig. 5 Mechanism plate assembly of Brownie movie camera

manufacture, and assembly techniques must be considered if the ultimate manufacturing cost of the product is to satisfy the initial requirements. It is during this phase that the production engineer can be a tremendous asset, or he can be a "no man" unwilling to take the calculated risks associated with the use of new materials and new methods. Ingenious production engineering done after the product design is complete can help but it cannot cure an uneconomical product design.

### Brownie Compared With Cine Kodak 8-25

To illustrate the differences between the product design of the Brownie Movie Camera conceived with the aid of a co-operative production engineer and product design conceived before the evolution of production engineering, another 8-mm movie camera, the Cine Kodak 8-25, designed prior to 1932, has been selected for comparison.

These two cameras, Fig. 1, have comparable features; in fact, the Brownie is superior to the 8-25 in most respects, yet the manufacturing cost of the Brownie is only 30 per cent of the cost of the 8-25 if the 8-25 were to be produced at today's labor and material costs by yesterday's methods. Two major factors account for this considerable difference in cost. The first is the increase in engineering experience as to the requirements of the basic design of motion-picture cameras. The second is the effect of the many materials and methods which are new or which have become economically practical. It is this second factor which will be of primary interest to production engineers.

Without attempting to differentiate between whether a material or method is new or merely has become economically useful, the Brownie is compared to the 8-25.

The 8-25 was designed so that all the major parts were mounted on the mechanism plate, Fig. 2, which in turn slipped into a drawn sheet-aluminum cover and a case, Fig. 3, on which was mounted the finder system.

The Brownie is composed basically of the following four major elements: (1) A sports-type finder system, shown in Fig. 1; (2) a light-tight box consisting of a molded phenolic front and a sheet-aluminum cover, side, and center band, Fig. 4; (3) a mechanism plate mounting a power source, a gear train, and film supply and take-up facilities, Fig. 5; and (4) a die casting which houses the lens, film-locating means, and combination governor and shutter, Fig. 6.

### Brownie Assembly Time Reduced

This design makes the assembly more suitable for the slide-box type of assembly handling which has been found most practical for production volumes which are variable or which do not justify mechanized conveyer systems. Particular care was exercised in the design to be certain that the parts could be made by the processes proposed and yet go together without hand-fitting. If the layout study indicated that no economical way could be provided to maintain satisfactory assembled toler-

Fig. 6 Shutter housing of the Brownie

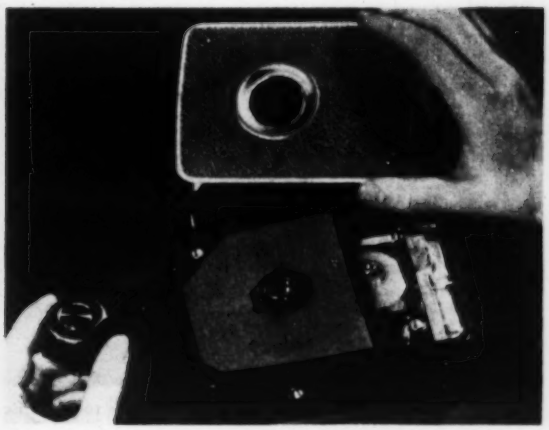

Fig. 7 Easy access to Brownie mechanism is provided

ances, convenient means were provided to make adjustments in assembly as rapidly and accurately as possible. This consideration of assembly methods early in the design stage contributes to the fact that the Brownie is assembled in 17 per cent of the time required for the 8-25.

Like any manufacturer we would be happy to say that all the cameras operate perfectly the first time they are assembled. However, since the Inspection Department does find a few cameras that need adjustment or replacement of defective parts, it is important that ease of repair be considered in the original design. As shown in Fig. 7, access to the Brownie mechanism is provided by the removal of two screws, the winding-key assembly, and the side panel. To accomplish this on the 8-25 requires about five times as long and involves the removal of a pin, the winding-key assembly, eight screws, the lens hood, the lens pointer, the diaphragm collar, and the entire mechanism from the case.

Among other factors contributing to the reduction in assembly time is the use of cross-recessed screws which helps to make practical the application of power screwdriving equipment by reducing the possibility of the driver slipping off the screwhead and marring the adjacent finish. Another is the use of tan Kodadur, a Kodak synthetic-coated fabric, the back of which is coated with one of the new thermoplastic adhesives. This cuts assembly time since it eliminates the operations of applying cement to the Kodadur and of cleaning off the excess after the assembly has dried in a form. Incidentally, this also makes it unnecessary to spray and bake a primer on the aluminum in the area to which the Kodadur is applied as this adhesive bonds firmly to the anodized aluminum.

### Dry Lubricant Used

An interesting departure from normal design of the spring motor assembly, shown in Fig. 5 (*left*), resulted from the use of a new dry lubricant, powdered molybdenum disulphide. The lubricants formerly used required a housing around the spring for best results. The application of a thin film of this new material lubricates the spring so that the coils do not jerk and cause the camera to jump when they slip on one another during unwinding. A loop of flat steel is riveted to the outer end of the spring along with the anchor loop. This steel loop surrounds the spring and acts as a keeper during shipment and assembly. It also prevents the spring from striking any of the moving parts in the camera when the spring is fully run down. This assembly costs only one fifth as much as the comparable spring motor and drum housing used in the 8-25.

### Molded-Nylon Gear Assembly

In the plastics field, the use of a molded nylon gear assembly, Fig. 8, contributed most to the lower cost of the Brownie. This assembly, molded as one piece, consists of a face gear, a pinion, and a spline for the take-up drive disk. While cut nylon gears had been used in previous designs, this was one of our first applications of molded gears. The cost advantage over an assembly of cut gears is illustrated by the fact that this assembly would cost eight times as much if made of cut metal gears staked together. In addition to the lower cost, the nylon assembly requires no further lubrication during the life of the camera.

Tenite was chosen for the lens diaphragm disk, Fig. 9, since it combines suitable color with good appearance and feel in the exposed portion which is knurled and which carries the figures designating the lens opening. At the same time it can be "flashed" in the diaphragm opening areas so that the lens openings can be perforated easily in the proper place and to exact size. The finished part costs just 14 per cent as much as the parts needed to perform the same function in the 8-25.

### Finishing Costs and Operations Reduced

The effects of new materials and methods on finishing costs were considerable, the over-all cost of finishing operations of the Brownie being only one third that of the 8-25.

Some savings were realized by the use of aluminum and stainless steel so that expensive plating operations were unnecessary. Stainless steels have been available for some time, but the ability to barrel-finish stainless-steel parts and then to spot-weld them together has made practical their use for parts exemplified by the release

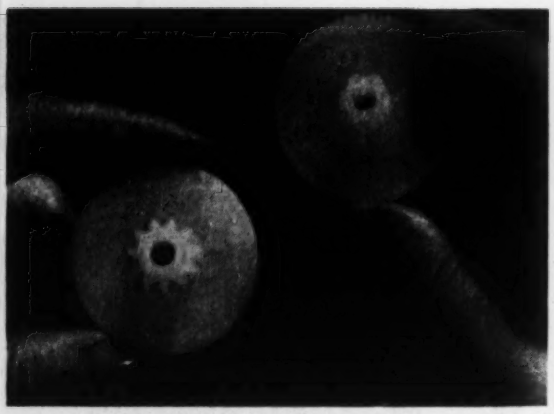

**Fig. 8 Molded nylon gear assembly contributes to Brownie's lower cost**

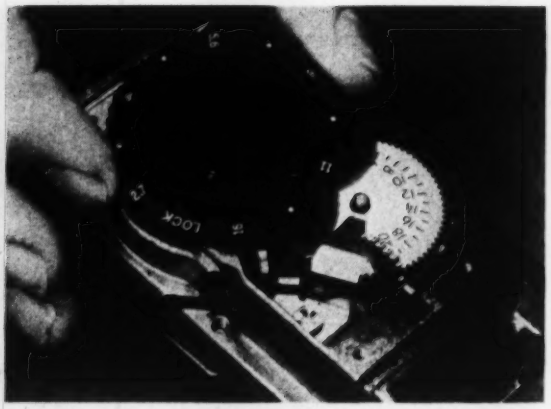

**Fig. 9 Tenite lens diaphragm disk on Brownie shutter housing results in cost savings**

lever for the Brownie. This part must act as a leaf spring at one end and yet be smooth and suitable in appearance in that portion of the other end which is exposed to view and to contact by the operator's finger tip.

One of several major finishing savings resulted from the use of the new synthetic polymerizing paints which give two-coat quality with a one-coat operation. They are applied directly over a preparatory phosphatizing treatment whereas the older paints require the operations of washing, primer coat, baking, finish coat and baking. At the same time these new paints reduce the baking time from $1^1/_2$ hr to 10 min. This latter effectively reduces the floor space and equipment needed to handle a given production volume and encourages the use of automatic spraying equipment, resulting in a reduction in cost and a more uniform quality.

Another saving of consequence resulted from the advances made in tumbling methods. In addition to the usual application of tumbling for deburring, precision tumbling was used to obtain a smooth surface suitable for plating or passivating. Precision tumbling is accomplished by a wet tumbling of a small number of parts with a large number of stones so that the parts seldom if ever touch one another, thereby preventing small nicks. This method was used where the final appearance was important and, in the case of two parts, the aperture plate and pressure pad, for surfaces on which the film slides and which therefore must be very smooth for functional reasons. The surface quality required had previously been obtainable only by a hand-buffing operation with the result that these parts for the 8-25 cost seven times as much to finish as for the Brownie.

Two items that affected the design of the Brownie and resulted in improvement in appearance over the 8-25 at no increase in cost are the finishing of the high lights on the side of the camera and the use of printed name plates.

In finishing the high lights the panels are placed on special racks which carry these parts through all the finishing operations. These include a chemical dip to even out any irregularities in the surface and give a high luster, followed by anodizing. The racks used must be designed so that the material removed during the chemical dip does not result in poor electrical contact during the anodizing. They also must be of sufficient cross section so that the material lost by the racks due to repeated action of the dip does not result in uneconomical life.

Name plates formerly were made by etching or embossing and filling. This produced a very neat and durable plate but was costly and required a rather expensive raw material. Most of our current one-color plates are printed on aluminum by the offset method at about one third their former cost. Multiple-color plates show an even greater saving. In fact, some of our new plates would be impractical if not impossible as etched plates. An indirect saving is the lower maintenance cost of the equipment, largely due to elimination of the use of acid.

### Sintered Cam

The least expensive method of moving the film intermittently behind the lens involves the use of an eccentric cam. Until the advent of sintered materials impregnated with oil, either lubrication of this cam was required during the life of the camera, or the surfaces contacting it had to be made of some permanently lubricated material such as graphite-impregnated phenolic. The use of the sintered cam gives the customer the convenience of the latter design without its increased cost.

### Conclusion

The intent of this paper has been to show how in the case of the Brownie Movie Camera we have attempted to give the customer the most camera for the least money by considering new materials and methods and reviewing older ones in light of the present economic conditions. Materials and methods that were applicable were incorporated into the original design so that little time was lost in redesign when the drawings were turned over to the Production Engineering Department and few savings had to be discarded because it was too late to change the design to incorporate them.

The specialized abilities of both the design engineer and the production engineer were realized fully, largely because these two were able to get together early in the layout stage and work together amicably throughout the design phase.

Similar co-operation in the design of the Brownie Movie Projector resulted in an equally successful cost reduction. As a consequence, the over-all equipment investment required by the prospective home movie producer was substantially reduced.

# OPERATIONS RESEARCH[1]

## War techniques adapted to the study of the operational behavior of men and machines

**By Philip M. Morse**

**Professor of Physics, Massachussetts Institute of Technology, Cambridge, Mass.**

**Operations Research is the application of research techniques to the study of the operations of war and peace. It examines what occurs when a team of men or machines does the job assigned to it. It is an activity; a pattern of operations, susceptible of being related to other diverse activities. Its applications encompass such unrelated matters as determining time of waiting in line in a restaurant; fixing the interrelation between sales fluctuations, size of inventories, and production scheduling; or developing a pattern of search operations for an enemy submarine or aircraft.**

THIS is a progress report on a relatively new branch of applied science. First utilized during the last war on military problems, it proved valuable enough so that most military staffs, here and in England, now have operations-research groups. More recently its usefulness in industry is coming to be recognized, and groups are also being attached to top industrial staffs. The Operations Research Society of America, formed two years ago, now has nearly 1000 members; its *Journal* is now in its second volume. What is this new activity, and how is it related to other branches of science and engineering?

Defining a branch of science in a few nontechnical terms is not easy. Perhaps the safest definition is that Operations Research is the activity carried on by operations-research groups and reported in the *Journal of the Operations Research Society of America*. But often some less circular sort of definition is desirable. Students who may wish to learn about the field have to be told what it is; people want to know what it's good for; workers in related fields want to know why it should be differentiated from their own fields, and so on.

### What Is Operations Research?

Operations Research has been defined as the application of the scientific method to problems of management, but this is obviously too concise and too general a statement. There are many sorts of "scientific methods," and many sorts of people study problems of management. Part of the definition must describe the way these problems are studied. Here the word "research" in the title may give a hint. The research scientist, at least in the physical sciences, uses the quantitative language of mathematics, employs the well-known but difficult-to-describe procedures of experimentation and theory making. He looks at the phenomenon he is studying in a certain impersonal way, being more interested in *how* than in *whither*, more interested in *why* than in *for what use*. Many centuries of experience have taught him that this impersonal viewpoint, this dual employment of theory and experiment, will usually procure for him results of value in his science and that too great a preoccupation with questions of the worth of the result, or the immediacy of the need, actually will hinder his progress.

Operations Research, then, is the application of research techniques to the study of the operations of war and peace. It is concerned with an attempt to understand something, in the scientific sense of the word "understanding." It is an effort to discover regularities in some phenomenon and to link these regularities with other knowledge so that the phenomenon can be modified or controlled, just as other scientific research does. The difference comes in the phenomena which are studied, the subject matter. Instead of studying the behavior of electrons, or metals, or gasoline engines, or insects, or individual men, Operations Research looks at what goes on when some team of men and equipment goes about doing its assigned job. A battalion of soldiers, a squadron of planes, a factory, or a sales organization is more than a collection of men and machines; it is an activity, a pattern of operation. These operations can be studied, their regularities can be determined and related to other regularities; eventually they can be understood, and they then can be modified and improved.

### Research at the Operational Level

Operations Research is concerned, not with matter or with individual machines or with men, but with the operation as a whole; with battle tactics, with strategic and logistic planning for future operations, with the interrelation between sales fluctuations, size of inventories, and production scheduling, with the flow pattern of goods in a group of factories or of traffic in a city, to

[1] Reprinted from *Applied Mechanics Reviews*, March, 1954, pages 89–93.

mention a few examples. We might use the word "level" to distinguish between the different subject material, if we can divorce the word from any connotation of relative importance or difficulty. Physics and chemistry would then correspond to research at the basic or material level, the study of bridges and television sets, research at the engineering or applied level. Operations Research would then be "research at the operational level."

Although the name is relatively new, research at the operational level is not new, of course. Taylor and his followers, in their time-and-motion studies, have investigated a small part of the whole field, traffic engineers have been working on another part, systems engineers encroach on it, and so on. Perhaps the most useful service the new term Operations Research has performed is to emphasize the essential unity of the whole field, to force the recognition of similarities in behavior in areas hitherto separate, and to make apparent the broad usefulness of a number of research techniques and mathematical models.

### Techniques Used

I have not yet said anything about the techniques used in Operations Research. As with other research, any technique of measurement or of calculation, any portion of a basic science is used which will produce results. We should expect that the theory of probability and of statistics would be very useful tools; we also should expect that the techniques of the psychologist would be needed in other cases. This does not mean that Operations Research is applied statistics, on the one hand, or is a branch of social psychology, on the other. It uses any and all of these disciplines to study operations in order that they may be understood and thus controlled. Since a wide variety of basic science is involved, much of the research can best be carried on by a team of workers having a variety of background training, each contributing his specialized knowledge to the solution of the operational problem. The advantage of a mixed team for the study of many operational problems is obvious. In fact, some persons have said that the use of mixed research teams is a characteristic of Operations Research. It certainly is important in many investigations; whether it is characteristic or necessary might be questioned.

But certainly further generalities will not be helpful here; a few specific examples may help clarify the picture. Certain particular aspects of operations have been the subject of intensive study in the last few years, and special mathematical models have been developed to help understand the phenomena. As is usual with models, they represent only part of the phenomena, and since Operations Research is new, most of these models need further development before they can be satisfactorily general in their applicability. Here the Operations Research worker needs the help of the basic scientist, particularly the mathematician.

### Waiting in Line

Take the simple business of waiting in line—the British call it queuing. All of us do it too much of the time; if we drive to work in the morning, we wait at traffic lights; if we go to a cafeteria at noon, we wait for our lunch. It is the headache of many businesses; it is a vital problem for airlines when an airport clouds in and the planes begin to stack up, waiting to land. Let us see what can be said about this sort of problem.

We start as usual with a fantastically simplified case, one where the front of the line is served at some constant rate, say, $S$ per second, and where the rear of the line is being filled up by people (or planes) coming in at random times but with an average rate of arrival, $A$ per second. We also will assume that this has been going on long enough so that a steady state has been reached; we can consider the transient case as a later elaboration. The key to this mathematical model lies in the working out of the various probabilities that the line will have 0, 1, 2, or $n$ persons in it. Call the probability that there are $n$ persons in the line $P_n$.

If $P_{10}$ is large, for example, this means that we are quite likely to find 10 people ahead of us when arriving in line; what the restaurant tries to do is to make $P_0$ large.

To have a steady state none of the $P$ should change with time.

But every time a person arrives, all the $P$ step up one by one, $P_0$ changes to $P_1$, and so on; and every time a person is served, they all change downward. So, in order that $A$ persons arriving a second and $S$ being served a second will not change the probabilities continually, they must be related in some special way. For example, the rate of disappearance of a line of zero length is $AP_0$, the rate of arrival times the chance that a zero-length line is there; the rate of appearance of a line of zero length is $SP_1$, the rate of serving times the chance that a single-length line is present. To have a constant probability of zero-length line, we must have these two rates balance; $AP_0 = SP_1$. Similar balance for lines of unit length, of length $n$, and so on, gives rise to the sequence of equations.

$$AP_0 + SP_2 = (A + S)P_1; \quad AP_{n-1} + SP_{n+1} = (A + S)P_n$$

and so on.

These can be solved without much trouble, giving $P_n = (S - A)\ (A^n/S^{n+1})$ as long as the rate of serving $S$ is larger than the rate of customer arrival $A$. It is obvious that if customers are arriving at a rate faster than they can be served, the line cannot ever be stationary in length and, if they value their reputation or peace of mind, our restaurant or airport managers must avoid this at all costs. But even when customers arrive more slowly than they can be served, we see that there is a finite chance that a line will form. In fact, the average length of the line turns out to be $A/(S - A)$.

This quantity is quite small as long as the maximum serving rate $S$ is at least twice the arrival rate $A$. But if people arrive nearly as fast as they can be served, the average waiting line rapidly lengthens; if $A$ is $0.8S$, then the average number in line is 4; if $A$ is $0.9S$, the line has 9 in it, on the average, and so on. For example, if $A$ is $0.8S$, if customers are served 25 per cent faster than they arrive, on the average, then 20 per cent of the time there will be no line, 16 per cent of the time one will be waiting, 13 per cent of the time two will be in line, 8 per cent of the time four will be waiting, 2 per cent of the time ten will be in line, and so on; the average line length will be four.

It may seem peculiar that there should be *any* waiting line when the mean rate of service is greater than the average rate of arrival; this is due to our assumption of *randomness* in service and arrival. We assume that each customer doesn't conveniently arrive just when the last customer has been served; the customers arrive at random,

which does *not* mean regularly. Also, one customer may take longer to be served than the next, and a bunch of customers every now and then arrive just when a slowpoke is being served.

These random mismatches between customer and server don't matter much if the service is considerably faster than the average rate of arrival; once in a long time two or three may come in a bunch, but most of the time no one is waiting. But if customers arrive nearly as fast as the line can be handled, these mismatches occur more and more often, and the chance of a long line occurring quickly is large. Of course, if the servicing process could be made absolutely regular, each service completed exactly in 10 seconds, for example, and if also we could regiment our customers to arrive exactly 10 seconds apart, so that one walked in the door exactly at the end of each 10 seconds, then $S$ could equal $A$, and still no line would form.

But service is very seldom as perfectly timed as this, and we practically never can regiment the arrivals. Customers, automobiles, and airplanes do arrive in a random manner at restaurants, street intersections, and airports, and it turns out that the results of our simple quantitative reasoning fit actuality remarkably well in spite of our preconceptions to the contrary. Here is a case where theory and actuality contradict our intuitive "feelings."

In every case where this theory applies, gross errors of estimate have been made, regarding the expected length of waiting lines, on the basis of nonmathematical "hunches." Often long arguments have occurred before the manager would be willing to face the consequences of the theory. They would continue to say, "But why should there be a waiting line when I can serve them faster than they are coming?" in spite of the line which was there before their eyes. The results of such irrational behavior only produce irritation in the case of restaurants, gasoline stations, and the like; it is much more serious in the case of airports or docking facilities in harbors, particularly under wartime conditions.

### Industrial Problems

The simple theory, sketched so quickly above, can be expanded and complicated almost indefinitely. For example, the problem of machine maintenance in a factory is of this sort. The machine can be said to "arrive in the waiting line" when it breaks down; it is "served" when it gets repaired. The flow of parts through an assembly line is another example. The theory can tell us how many parts must be kept on hand at each stage of the process, in order that no machine should be kept idle by delay in the earlier processing, for example. Many aspects of the over-all problem of industrial inventories also can be analyzed by this technique. Here it is the sales, the outflow, which has the large fluctuations; we need to balance between the requirement that orders be filled as soon as they come in and the added expense of running a factory overtime if our inventory runs out.

Another sort of problem which turns up in a large number of operational studies has to do with the optimization of some function of a number of variables, subject to boundary conditions which limit the range of the variables. For example, an oil company can produce various proportions of fuel oil, gasoline, and aviation fuel from its cracking plants, depending on the kind of crude oil used, and can produce various proportions of these end products from a given crude, depending on the cracking process used. But crudes differ in price, and cracking processes differ in cost. Suppose the company has orders for definite quantities of end products to be delivered in the next 3 months. What amounts of which crude shall it buy, and which processes shall it use in its cracking plants, to produce the required amounts of products at the least cost, subject to limitations of supply of crudes and of output of its plants?

The variables here are the various amounts of crudes to be bought and the degree of utilization of each plant. The function to be minimized is a linear function of these variables, and the limits on each variable are known accurately. Such a problem is known as a "linear programming" problem. There are many such problems which turn up in Operations Research. Techniques of solution are not simple, and many of them require high-speed computing machines; much further mathematical research is needed to simplify computing procedures in linear-programming calculations.

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**In Operations Research there is an opportunity for scientists and engineers to help in administrative problems, not by becoming the administrator, but by providing the administrator with quantitative understanding of aspects of his operational problems, so that he can reach a wise decision, fully conscious of the implications of his choice.**

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Parenthetically, the optimization of the crude-oil-cracking problem has been worked out by the research or the engineering departments of many large oil companies. The persons who worked out those solutions did not call what they were doing Operations Research; many of them had not heard of Operations Research. It is also true, however, that most of these workers were not aware that many other problems in the company's operations were likewise amenable to the same analysis. The value of the concept of Operations Research to these companies lies in making their research men aware that the techniques of theoretical analysis they have been using for one problem can be applied to a much wider range of operational problems than they hitherto had conceived, and in showing the company executives that they can use their own research departments to help solve production and sales and distribution problems, where formerly they had not been used.

### Linear Programming

The linear-programming problem can be visualized most simply in geometrical terms. The $n$ variables define an $n$-dimensional space; a point of this space corresponds to a solution. Each limitation on the range of the variables corresponds to a hyperplane in this space,

restricting the allowed solution points to one side of the hyperplane. By the time we have finished specifying all the restrictions (negative production not allowed, maximum limits on storage capacity, limits on production, and so on) we find that we have surrounded the region of possible solution by hypersurfaces, so that the allowed region is the interior of a convex polyhedron in the hyperspace. If the function to be optimized is a linear function of the variables, then the requirement that this function have some constant value also corresponds to a hyperplane which may or may not cut through the polyhedron; if it does, it then corresponds to an operationally possible value of the function to be optimized. By changing the value of the constant, we can generate a family of hyperplanes parallel to each other, their distance from the origin being proportional to the value of the function to be optimized.

Some of the hyperplanes in this family cut through the polyhedron containing the region of solution; some do not. There are two limiting hyperplanes, one corresponding to the largest value of the function for which the hyperplane just touches the polyhedron, and one corresponding to the smallest value which just touches. Consideration of the geometry shows that for most orientations of the family of planes the two limiting planes just touch a vertex of the bounding polyhedron and thus contain just one possible solution compatible with all the boundary conditions. The outermost limiting point is the optimum solution if the function is to be maximized; the innermost point is optimum if the function is to be minimized. Once the geometry is clear in one's mind, it is easy to visualize the solution. But, at present, it is not easy actually to compute the optimum vertex when there are several dozen variables and about a hundred boundary faces of the polyhedron.

### Production Planning Needed

Important as linear-programming techniques are, they need further generalization to be able to solve many problems in Operations Research. Production planning is an example. A factory can produce so many units of some product each month, but sales of the product are small during the summer and very large in December, so large that fall production cannot equal December sales. One solution is to run the factory overtime during the fall; but overtime production costs more than normal output. Another solution is to produce more during spring and summer and store it ready for the winter rush; but warehousing also costs money, in storage and handling charges and in interest on the money tied up. A third solution of course is to fail to meet orders in December, but this is a counsel of despair.

It should be evident by now that this is also a linear-programming problem. The variables are the regular production each month and the overtime production each month. The excess of production over sales each month is warehoused. The boundary conditions are the limits on the production and overtime production each month and the additional requirements that the total production from the first of the year shall never be less than total sales from the first of the year. The quantity to be minimized is the total cost, including overtime charges and warehousing charges.

As stated, this is a straightforward linear programming problem, *if* we can predict exactly our sales throughout the coming year. If our sales forecast is exact, we can proceed to find the distribution of production and overtime production each month to minimize total costs and to satisfy all forecast sales. The trouble is we never know exactly what the sales are going to be, and if we have underestimated them, we will not be able to meet orders; if we have overestimated them, we will end the year with unsold product in our warehouse. All we really have is a probability distribution of expected sales; to put it pictorially, some of the sides of the bounding polygon are fuzzy, not sharp.

### Problems of "Bounded Optimization"

At present, our techniques of solution are not adequate for such problems, nor are they if the function to be optimized is not a linear function of the variables. Such more general problems might be called problems of bounded optimization. The problems are clear, but a great deal of further analysis and devising of computational techniques is needed before solutions can be obtained with the requisite ease. Speed of solution is needed here, for in many cases we wish to find a whole sequence of solutions as we vary some of the limits: What happens if we build another factory, or if we close down our factory in August, for example? When solutions of problems of bounded optimization are easy to obtain, many tough problems of planning, of production, of sales effort, of logistics, and so on, will be easier to solve.

Another kind of problem for which a mathematical model can be built came up first in naval operations research but has numerous business analogs. It concerns the operation of "search" for an enemy vessel, or submarine, or aircraft. The enemy is somewhere in a given area of the sea. How do you deploy your aircraft to find him? The central idea here is the "rate of search." A single plane can see the enemy vessel (by radar or sonar or visually as the case may be) $R$ miles away, on the average. The plane can "sweep" out a band of width $2R$ as it moves along; the picture is analogous to a vacuum cleaner, of width $2R$, sweeping over the ocean at a rate equal to the speed of the plane and picking up whatever comes beneath it. An area equal to the speed of the plane times twice the mean range of detection will thus be swept in an hour. The sweep rates of planes vary from a few hundred square miles per hour to several thousand square miles per hour, depending on the plane, the radar equipment, and the vessel searched for.

If the enemy is equally likely to be anywhere within a certain area, then the problem is a straightforward geometrical one. The search effort is evenly laid out over as much of the area as one has planes available. The problem is a little complicated by the fact that detection is not certain at extreme ranges, so the probability of detection falls off near the edge of the swept band and there should be a certain amount of overlap between bands to improve the chance of detection near the edges.

But if the chance that the enemy is present varies from area to area, the problem becomes quite difficult; nonmathematical intuition may lead to quite erroneous use of available effort. For example, if the enemy is twice as likely to be in one area than in another, then, if only a small amount of search effort is possible, *all* this effort should be spent in searching the more likely area. If more effort is available, some time can be spent on the less likely area, and so on. A definite formula can be worked out in each specific case. Search plans for vari-

ous contingencies were worked out by the Operations Research team attached to the Navy during the war; they materially aided the naval efforts in many cases.

### From War Effort to Industry

It seems a far cry from planes and ships and submarines to industry and business activities. But the utility of the mathematical models is their wide range of applicability. One possible business application of search theory comes in the problem of assignment of sales effort. Suppose a business has a limited number of salesmen, who are to cover a wide variety of dealers. Some of these dealers are large stores, which usually will produce large orders when visited, some are small stores with correspondingly smaller sales return. If there are enough salesmen, every dealer can be visited every month, and the optimum number of sales can be made, although the sales cost will be high. With fewer salesmen available, search theory indicates that the larger stores should be visited more often than the small stores; with very few salesmen it may be that only the large stores should be visited. If the probable return per visit for each store is known, the optimum distribution of sales effort can then be calculated.

An interesting and typical variation on this problem comes when we consider the action of the individual salesmen, when we try to make their behavior conform to the best over-all distribution for the company. For each individual salesman, with his limited effort, it may be best *for him* to visit only the large stores; if his visits are uncontrolled and if he is paid a flat commission, it may turn out that the large stores are visited too often, the small stores too seldom, for best returns *for the company as a whole*. It then becomes necessary to work out a system of incentive commissions designed to induce the salesmen to spread their efforts more evenly between large and small customers. If the general theory has been worked out, this additional complication can be added without too much difficulty.

This problem of balancing the tendencies of different parts of a large organization is one which is often encountered in industrial Operations Research. The sales force is out to increase sales of all items, though some items may return less profit than others. Production resists changeover to making another product, though sales on the other product are increasing; and the financial department frowns on building up large inventories, though small inventories always put the production division at the mercy of sales fluctuations. It is often not too difficult to suboptimize each of these divisions separately, so each is running smoothly and effectively in so far as its own part of the business is concerned. But to be sure that all these parts mesh together to make the company as a whole operate most efficiently requires much more subtle analysis and very careful quantitative balancing.

In the interest of reducing factory overtime and to keep down inventory, for example, it may be necessary to modify the salesman's incentive commissions, so he will be induced to push one line over another. It may be necessary for the production division to allow more overtime in one department than another, to make some part of its operation run at less than optimum in order that the over-all operation be optimum; and one must take care not to penalize the production department, by reduced bonuses or the like, for reducing its efficiency so that the effectiveness of the whole is improved.

But perhaps these few simple examples are enough to show that the research techniques developed to increase our understanding of the nature of the physical world also can be used to help us understand operational problems. In many cases in industry and war, a simplified quantitative model of the situation can help us see what goes on and can help us devise the best way to proceed. In many cases it is not necessary to have a complete picture of all that goes on, clear down to all the basic details. As long as our mathematical model can be adjusted to fit some of the regularities which appear, we can abstract these parts of the behavior from the rest and study them separately. The process of abstraction, of keeping clear of local details, has the advantage of providing a model which may fit a variety of circumstances—restaurants, production lines, or landing aircraft. By gaining in generality, of course, we lose in detail.

Perhaps it also can be seen that such methods probably cannot be used to solve all problems. Just as it is quite unlikely that the methods of analysis used so successfully in genetics can be used to solve all biological problems, for example, so it is unlikely that the Operations Research scientist, with his specialized techniques of analysis, can ever replace the usual business executives or army generals, with their practical experience and their intuitive grasp of the complicated effects of morale and applied psychology, for example.

But as the new techniques are tried in more and more different fields, it should become clear what operational situations can be analyzed by its means and what situations cannot. Already there are Operations Research teams working closely with military and industrial administrators, exploring these possibilities, reporting their findings to the administrator that he may be able to combine their quantitative results with his experience and judgment to reach more understanding decisions.

In general, scientists and engineers have not been active in administering government or business. This is not surprising, for the business of science is to understand, not to act. In Operations Research, however, the scientist and engineer can provide a better understanding of operational problems so administrative decisions can be made wisely.

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Research, broadly speaking, is subdivided for convenience by such concepts as fundamental or basic research and applied research, and is often confused with the engineering phase of development.

As anyone working in this field immediately recognizes, these terms define areas which in concept may differ, but which in practice shade one into the other. Furthermore, it is obvious that research does not apply merely to the so-called sciences, but applies equally well to unscientific, or perhaps more accurately, incommensurable material, as dealt with in the social sciences, or the humanities.

It would be very simple to establish the fact that throughout the ages activities described in these terms have shaped the course of man, and of his civilization. In earlier days, conflict existed between the fruits of scientific speculation and the dogmas of theology. As of today, religion acknowledges the fruits of scientific research. Thus, even the most dogmatic and universally accepted theologies have been enriched and broadened by man's scientific research efforts.—J. Carlton Ward, at the AAAS 120th Annual Meeting.

Fig. 1 The 2400-hp "Trainmaster" all-purpose locomotive

# A Report on Progress in Railway Mechanical Engineering—1952-1953

WITH the motive-power inventory of the domestic railroads heavily stocked with diesel-electrics, U. S. builders are allotting more attention to foreign markets and their requirements for locomotive models peculiarly fitted to work on the generally lighter track structures and smaller gages found in much of the overseas railway properties. During the year several builders brought out new models for this trade, designs characterized by the use of components—engines, generators, and so on—that have been proved in domestic service. Several of the new designs are described in this report. European builders also are active in and building for the export market and several have brought out large-powered diesels with mechanical drive for shipment to countries outside of the European continent.

The German builders, in particular, seem to be moving away from electric drive for diesel motive power and are bringing out high-powered locomotives and trains with torque-converter drive with a significant increase in horsepower/weight ratios. *Diesel Railway Traction*, August, 1953, directs attention to the fact that of the 13 diesel rail cars, rail buses, and locomotives shown at the 1953 Munich Transport Exhibit all are equipped with mechanical transmissions and hydraulic couplings or torque converters.

Substitution of mechanical drive for the conventional electric-drive system, characteristic of the vast majority of American diesel locomotives, also continues to engage the attention of some of the American builders. An experimental unit incorporating an 800-hp engine made its appearance at the Atlantic City AAR Convention in June, 1953.

The comparative ease with which electric-drive locomotives can be built and operated from a single operating position in multiple units, coupled with limitations in diesel-engine sizes and the desirability of using the simple two-axle swivel truck as the basic running-gear unit, until recently has tended to discourage any great amount of effort to incorporate appreciably large engine horsepower in single-cab diesel locomotives. Motive-power pooling possibilities and general flexibility of operation also have encouraged the retention of the "building-block" principle in locomotive composition, particularly for road freight service. However, with the diesel-electric now established as the basic motive-power type, operating refinements aimed at improved unit performance and still lower operating costs are pointing up the desirability of higher horsepower per motive-power unit. The builders are meeting this demand by the development of single units incorporating larger engines, but with relatively little increase in horsepower per ton on drivers. Undoubtedly the American railroads can use motive power endowed with greater horsepower per ton of adhesive weight—indeed, improvement along these lines would appear to be essential if the railroads are to continue to compete successfully with other forms of transportation.

More intensive supercharging and higher engine

Report of Committee RR-6, Survey: Chairman, T. F. Perkinson; members, F. A. Benger, R. M. Coultas, and F. L. Murphy.

Contributed by the Railroad Division and presented at the Annual Meeting, New York, N. Y., November 29-December 4, 1953, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

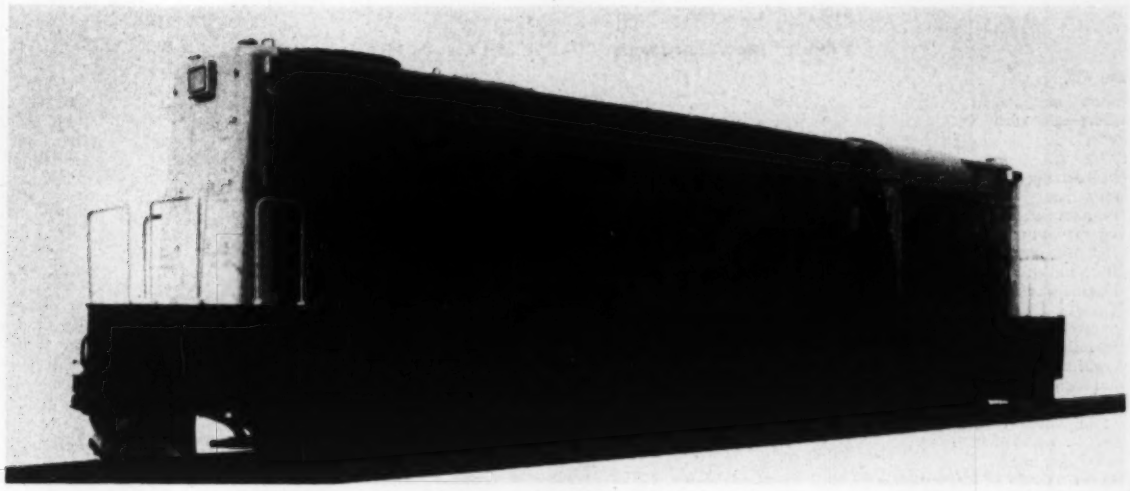

Fig. 2 Meter-gage 1600-hp unit for Brazil

speeds would appear to be the principal factors that will contribute most toward the attainment of this objective of higher horsepower per ton on drivers by the diesel locomotive.

### European Diesel Developments

Continental European designers appear to be more advanced in producing diesel engines of relatively large horsepower running at high speeds than are their American and British counterparts. Single engines rated at 1600 hp and running at 1600 rpm are available for locomotive application in Germany. Engines rating 1000 hp at 1500 rpm are being applied in double-engined 2000-hp locomotive units by the Germans.

Another reportable item in the field of diesel traction is the appearance of air-cooled engines which are being applied in Continental Europe chiefly in rail cars and rail trains. The largest available currently is a 250-hp engine arranged in a "flat" design of 12 cylinders adaptable to undercar mounting for either hydromechanical or electric drive. The application of a smaller-powered unit to a two-power switching locomotive is described elsewhere in this report.

A growing familiarity with diesel operating techniques and a realization that the diesel-electric shows greatest economies when it is thoroughly divorced from steam-operating and maintenance facilities have brought about large-scale abandonment of steam shops, particularly running repair points, and the construction of new maintenance and servicing facilities, peculiarly fitted to the most efficient and economical handling of the new type of "Iron Horse." Several of the larger systems are completely dieselized and others are moving toward this status at a pace limited only by financing considerations and the capacity of the builders to make deliveries.

### Railroad Electrification

In the realm of railroad electrification the commercial-frequency system, wherein the contact system carries alternating current at the frequency standardized for commercial and industrial use—either 50 or 60 cycles—seems to be attracting the serious attention of several countries interested in establishing a common national standard for long-range electrification programs.

Operation of one such system was inaugurated during the past year in the Belgian Congo and a description of the locomotives employed is given in this report.

The French National Railways continue the work of electrifying a heavy traffic line in northeastern France utilizing a 25,000-volt 50-cycle single-phase contact system to supply a variety of motive-power types, some of which are experimental in nature with a view to determining preferred types for use in further extensions of commercial-frequency electrification.

Experimental operation of a 50-cycle installation, converted from a previous 25-cycle line, and now using rectifier multiple-unit trains, was started in England. Initially this experiment is being conducted at the same voltage (6600) employed for the 25-cycle system, but provisions for elevating the contact-system voltage to 20,000 volts, should experience dictate, have been made. The rectifiers used are reported to be of the sealed steel-tank pumpless air-cooled type.

Running counter to this trend is the intended adoption of a 20,000-volt, $16^2/_3$-cycle, single-phase system for the electrification of the New Zealand Government Railways—a choice made after a careful study involving the economics of the system selected in comparison with a commercial-frequency system and two d-c systems, one of the latter (1500 volts) being already in limited service in New Zealand.

Despite the seemingly overwhelming tide of dieselization, electric motive power seems to be holding its position where traffic density and terminal-operating requirements call for performance that the electric and only the electrically propelled vehicle can deliver. Orders for ten 4000-hp rectifier locomotives and 100 rectifier-equipped multiple-unit cars for operation in the New Haven's electrified territory were placed during the past year. In addition foreign builders continue to produce a wide variety of electric motive power—some for new installations but largely for existing electrifications.

**Table 1 Diesel Locomotives (U.S.A. and Canada Manufacture)**

| Item No | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Builder—mechanical | F-M | GE | BLH | ALCO | ALCO | GE | BLH | BLH |
| Builder—electrical | W-GE | GE | W | GE | GE | GE | W | W |
| Owner | Various | C of B | Various | U. S. Army | Various | Indonesia | Brazil | Argentine |
| Service | All | F&P | RS | F&P | F&P | F&P | F&P | F&P |
| Wheel arrangement | C-C | C-C | C-C | C-C | C-C | C-2-C | C-C | C-C |
| Engine data: | | | | | | | | |
| Engines per cab | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Hp rating per engine | 2400 | 1600 | 1600 | 1600 | 1600 | 1600 | 1600 | 1500 |
| No. of cylinders | 12 | 12 | 8 | 12 | 12 | 12 | 8 | 8 |
| Bore and stroke, in. | $8^1/_8 \times 10$ | $9 \times 10^1/_2$ | $12^3/_4 \times 15^1/_2$ | $9 \times 10^1/_2$ | $9 \times 10^1/_2$ | $9 \times 10^1/_2$ | $12^3/_4 \times 15^1/_2$ | $12^3/_4 \times 15^1/_2$ |
| Engine speed, rpm | 850 | 1000 | 625 | 1000 | 1000 | 1000 | 625 | 625 |
| Cycles | 2 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Supercharging | — | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| Manufacturer | F-M | ALCO | BLH | ALCO | ALCO | ALCO | BLH | BLH |
| Weight on drivers, lb | 375000 | 214000 | 360000 | 240000 | 211500 | 158400 | 222600 | 231000 |
| Total locomotive weight, lb | 375000 | 214000 | 360000 | 240000 | 211500 | 211600 | 222600 | 231000 |
| Fuel capacity, gal | 1800 | 1400 | 1900 | 1600 | 1600 | 500 | 1300 | 650 |
| Driving wheel diam, in. | 42 | 36 | 42 | 40 | 40 | $35^3/_8$ | 42 | 36 |
| Type of transmission | Elec. | Elec. | Elec. | Elec. | Elec. | Elec. | Elec. | Elec. |
| Track gage, in. | $56^1/_2$ | $39^3/_8$ | $56^1/_2$ | $56^1/_2$–66 | $39^3/_8$–66 | 42 | $39^3/_8$ | 66 |
| Maximum permissible speed, mph | 65–80 | 60 | 60 | 65 | 65 to 92 | 62 | 45 | 75 |
| Fig. No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |

In the face of continuously declining passenger patronage, the domestic railroads, with few exceptions, are curtailing passenger-train service where regulatory agencies and public sentiment permit, retaining those runs that must be maintained for one reason or another. Despite this discouraging atmosphere some efforts are being made to retain or regain passenger patronage by the addition of new passenger cars, largely, but not entirely, conventional in basic design. No new or radically different rolling stock for this service made its appearance during the past year, but several refinements or extensions of previously reported innovations are worthy of note and are covered elsewhere in this survey.

Considerable attention is being allotted to the "piggyback" idea of rail transport of highway freight carriers and several experimental designs of truck and trailer-carrying freight-train cars, with their associated loading systems, have been developed in recent months.

Accelerated freight-train schedules—particularly those involving perishable lading in refrigerated cars—have demonstrated that currently-available equipment is capable of more intensive utilization when supplemented by suitable servicing facilities and improved operating practices. In some cases the use of roller-bearings on freight equipment is permitting higher-speed operation than was practicable formerly, with a resultant improvement in service and a betterment of operating costs.

## Diesel Locomotives—Domestic and Canadian

Notable among the new designs produced during the past year is the Fairbanks-Morse "Trainmaster"—a C-C, 195-ton unit carrying a 2400-hp opposed-piston engine of the 2-cycle type. While this unit is not the largest, in point of horsepower in a single cab yet built in the United States, since a number of 3000-hp 2-engine cabs were constructed by Baldwin in the middle 1940's (1),[1] it is the largest currently in commercial production in the United States. Dimensional characteristics of the Trainmaster are given under item 1 of Table 1, and Fig. 1 illustrates one of the units.

Fig. 2 and item 2 of Table 1 describe a 1600-hp meter-gage unit furnished the Central of Brazil by General Electric and equipped with an ALCO engine.

A six-axle 1600-hp road switcher, shown in Fig. 3, and described under item 3 of Table 1, has been added to the Baldwin-Lima-Hamilton line of locomotives. Dynamic-braking resistors, mounted in the radiator compart-

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

**Fig. 3 1600-hp road switcher diesel-electric**

Table 1 (*continued*)

| Item No. | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|
| Builder—mechanical | GMC | GMC | EMD | ALCO | GE | GE | BLH |
| Builder—electrical | GMC | GMC | EMD | GE | GE | GE | W |
| Owner | Various | Various | Exper. | Various | Cuba | Chile | USAF |
| Service | F&P | F&P | S | S | RS | RS | S |
| Wheel arrangement | A1A-A1A | B-B | B-B | B-B | B-B | C+C | B-B |
| Engine data: | | | | | | | |
| Engines per cab | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Hp rating per engine | 1125 | 1125 | 800 | 800 | 800 | 600 | 400 |
| No. of cylinders | 12 | 12 | 8 | 6 | 6 | 6 | 12 |
| Bore and stroke, in. | $8^1/_2 \times 10$ | $8^1/_2 \times 10$ | $8^1/_2 \times 10$ | $9 \times 10^1/_2$ | $9 \times 10^1/_2$ | $9 \times 10^1/_2$ | $5^3/_4 \times 8$ |
| Engine speed, rpm | 800 | 800 | 800 | 1000 | 1000 | 1000 | 1200 |
| Cycles | 2 | 2 | 2 | 4 | 4 | 4 | 4 |
| Supercharging | — | — | — | Yes | Yes | Yes | Yes |
| Manufacturer | EMD | EMD | EMD | ALCO | ALCO | C-B | Cater. |
| Weight on drivers, lb | 105000 | 160000 | 230000 | 230000 | 159000 | 141100 | 122100 |
| Total locomotive weight, lb | 158000 | 160000 | 230000 | 230000 | 159000 | 141100 | 122100 |
| Fuel capacity, gal | 800 | 1200 | — | 635 | 750 | 400 | 500 |
| Driving wheel diam, in. | 40 | 40 | — | 40 | 36 | 33 | 40 |
| Type of transmission | Elec. | Elec. | Hydra | Elec. | Elec. | Elec. | Elec. |
| Track gage, in. | $39^3/_8$ | $39^3/_8$ | $56^1/_2$ | $56^1/_2$ | $56^1/_2$ | $39^3/_8$ | $56^1/_2$-66 |
| Maximum permissible speed, mph | 60 | 60 | 40 | 60 | 68 | 50 | 51 |
| Fig. No. | — | 9 | — | 10 | 11 | 12 | 13 |

F = freight; P = passenger
S = switcher; RS = road-switcher
F-M—Fairbanks, Morse & Co.
ALCO—American Locomotive Co.
BLH—Baldwin-Lima-Hamilton Corporation.
GE—General Electric Co.—U. S. A.
EMD—Electro-Motive Div.—General Motors Corp.
GMC—General Motors, Ltd.—Canada.
W—Westinghouse Electric Corporation.
Cater.—Caterpillar Tractor Co.
C-B—Cooper-Bessemer Corporation.
C of B—Central Railway of Brazil.
Indonesia—Indonesian State Railways.
Argentine—Argentine State Railways.
Cuba—Guantanamo and Western RR—Cuba.
Chile—Chilean State Railways.
USAF—United States Air Force.

Fig. 5 "World Locomotive" adaptable to various gages

Fig. 4 U. S. Army variable-gage unit

ment where the radiator-cooling fan is used for cooling both the radiators and the braking resistors, are a feature of the new design.

American Locomotive made delivery to the U. S. Army of a new design of locomotive arranged for adaptation to any of the world's standard wide gages—from $56^1/_2$ in. to 66 in.—with an over-all weight of 120 tons on six motored axles. Fig. 4 shows the new unit and item 4 of Table 1 gives characteristic data. Basically the unit is a modification of the ALCO 1600-hp road switcher but with two additional motored axles, 800 gal of additional fuel capacity, and winterization equipment for extremely cold-climate operation.

Another ALCO development is the so-called "World Locomotive" aimed at the export market and designed for adaptability to any gage ranging from meter ($39^3/_8$ in.) to 66 in. The unit is an adaptation of the standard

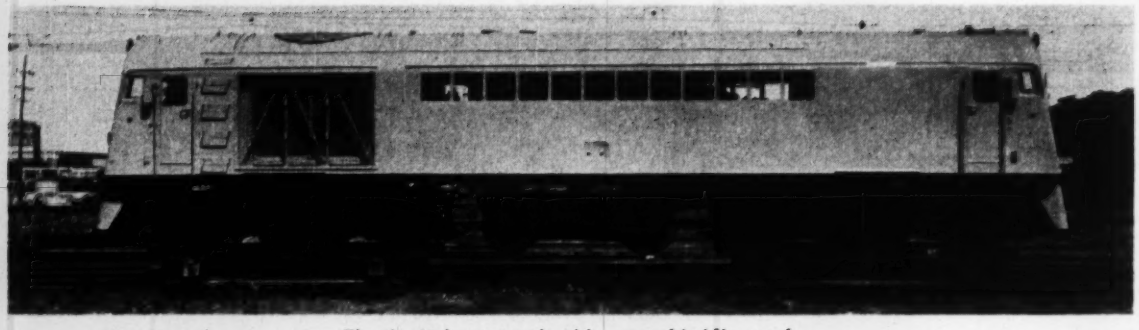

Fig. 6 42-in-gage unit with removable idler truck

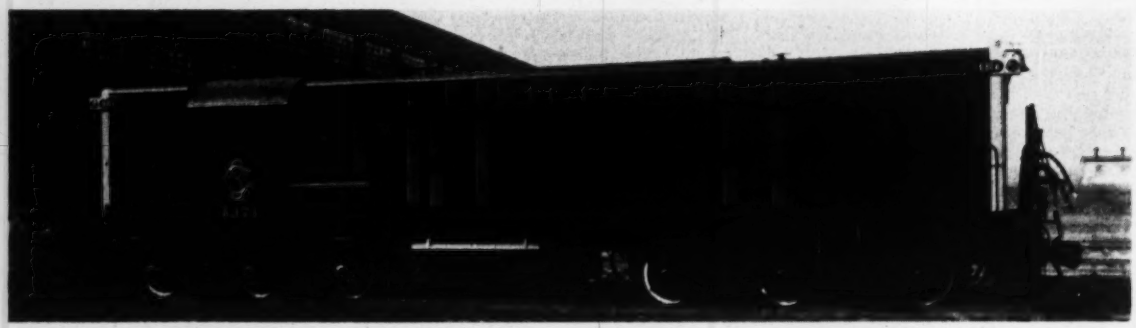

Fig. 7 Baldwin-built 1600-hp meter-gage unit

Fig. 8 Streamlined freight-passenger unit for Argentina

1600-hp road freight unit, with cab and body design altered to meet restricted clearance and loading requirements of tunnels, bridges, and other structures. Basic components such as engine, generator, controls are the same as used in standard domestic units, but the traction motors are of special design to permit mounting within the restricted space occasioned by meter and 42-in-gage trackage. Fig. 5 shows the locomotive in service and item 5 of Table 1 gives salient characteristic data applying.

Fig. 6 depicts a 1600-hp 105-ton diesel-electric for the 42-in-gage Indonesian State Railways built by General Electric. The running gear consists of two three-axle (all-motored) trucks with an intermediate idler, or weight-carrying, two-axle truck between the two outside trucks. The design is arranged to permit removal of the inside two-axle truck to provide a C-C running gear, after contemplated roadbed and structure improvements permitting heavier axle loadings have been made to the Indonesian lines. Item 6 of Table 1 lists data applying.

A 1600-hp meter-gage unit built by Baldwin-Lima-Hamilton for service in Brazil is shown in Fig. 7 and described under item 7 of Table 1. A newly developed Westinghouse traction motor for narrow-gage applications is employed.

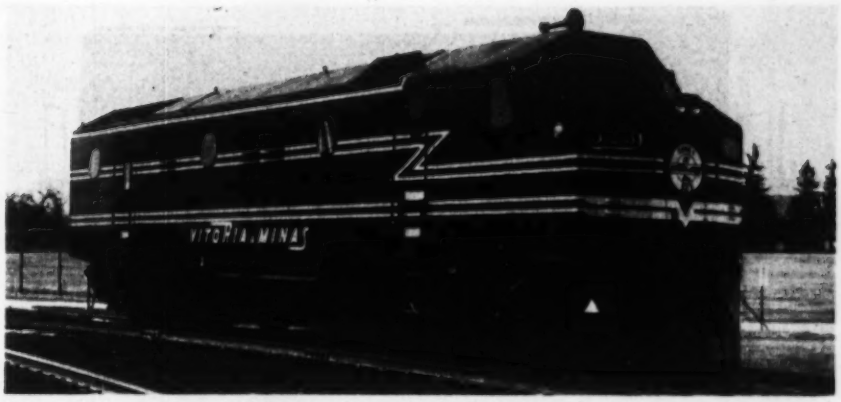


Fig. 9 B-B 1125-hp unit for meter-gage applications

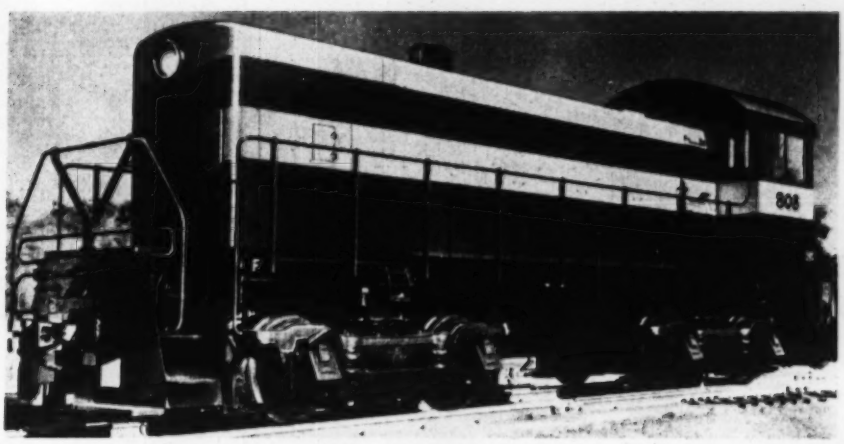


Fig. 10 New 800-hp switcher introduced by ALCO

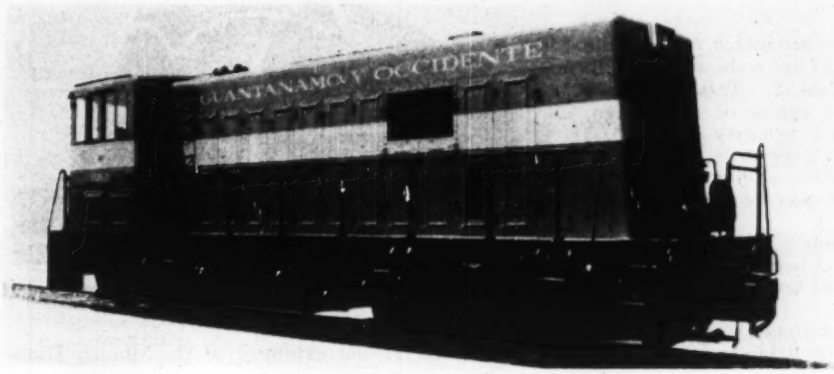


Fig. 11 An 800-hp unit for service in Cuba

A streamlined design built by Baldwin for the Argentine State Railways is shown in Fig. 8 and described under item 8 of Table 1.

General Motors (Canada) has produced two designs for the export market utilizing the EMD 12-cylinder 2-cycle engine rated at 1125 hp. Item 9 of Table 1 describes the unit with an A1A-A1A wheel arrangement, while Fig. 9 and item 10 describe the B-B design.

Item 11 in Table 1 lists dimensional characteristics of an experimental diesel-hydraulic switching locomotive built by Electro-Motive. The unit incorporates an 800-hp engine driving through a hydraulic torque converter supplemented by a three-speed automatic gear shift. A continuous tractive effort of 57,500 lb at 2.6 mph is available at the rail. Power transmission from the centrally located (on the cab underframe) gear set is accomplished through a system of telescoping universally jointed shafts driving into double-reduction gear

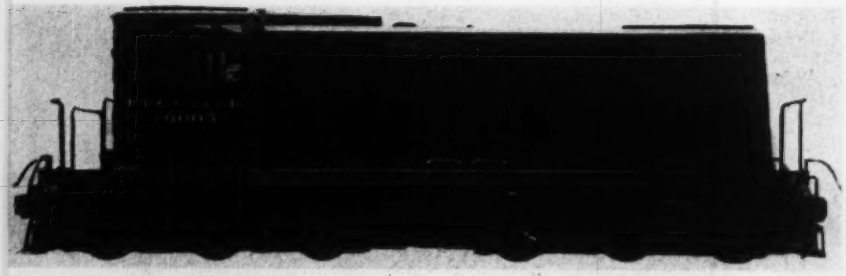

Fig. 12 Articulated 6-axle unit for Chilean State Railways

Fig. 13 Variable-gage unit for U. S. Air Force

boxes, one of which is mounted on each of the four axles in two two-axle swivel trucks. This application represents the largest horsepower installed to date by an American manufacturer in a diesel locomotive with other than electric drive.

The new 800-hp 115-ton switcher which replaces the 660-hp 100-ton unit in the ALCO line is shown in Fig. 10 and described under item 12 of Table 1. This locomotive carries a 6-in line supercharged engine of new design, which utilizes the same cylinder geometry ($9 \times 10^1/_2$) of the ALCO standard 1000-rpm engines.

Item 13, Table 1, covers an 800-hp unit built for service in Cuba by General Electric, employing the new ALCO 800-hp engine, Fig. 11.

A six-axled articulated running-gear unit for service on the meter-gage lines of the Chilean State Railways is shown in Fig. 12 and described under item 14 of Table 1.

The locomotive carried under item 15 and shown in Fig. 13, is a design developed by Baldwin for the U. S. Air Force for service on standard wide gages between $56^1/_2$ and 66 in., obviously for use in overseas as well as domestic services. Provisions are made for operation over an ambient-temperature range from —40 to 125 F, and for operation with equipment carrying any of a variety of domestic or foreign couplers.

### Diesel Locomotives—Foreign

Figs. 14 and 15 show a 2000-hp 2-engine hydraulic-mechanical drive diesel locomotive built in Germany

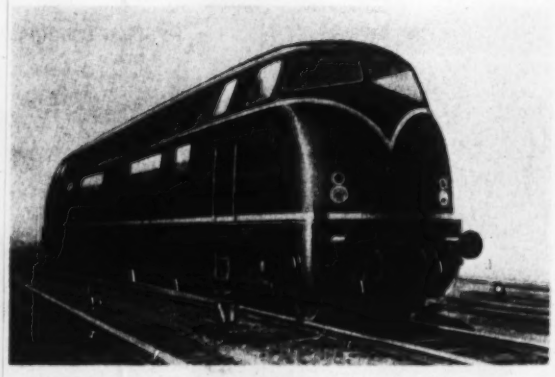

Fig. 14 2000-hp unit with hydraulic drive

by Krauss-Maffei and exhibited at the Munich Transport Exhibition. Two 1000-hp 1500-rpm supercharged Maybach engines driving through "Mekydro" transmissions, 2, into a B-B wheel arrangement, as shown in Fig. 15, are employed. With a total weight of 85 tons, all on drivers, and on the assumption that 1800 hp is available to the transmissions for traction, the horsepower per ton works out to 21.2. This ratio contrasts sharply with that found in comparably powered road diesel-electric locomotives of American manufacture, which show ratios in the general range of 12 to 16. Contributing largely to the high ratio found in

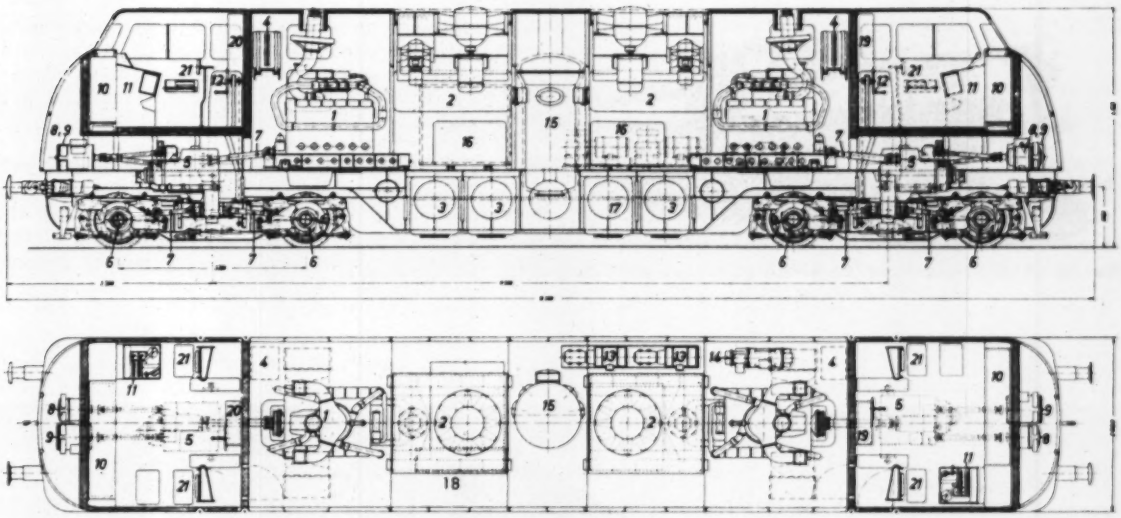

**Fig. 15 Apparatus layouts of 2000-hp diesel locomotive**

1 Diesel engines
2 Cooling equipment
3 Main fuel tanks
4 Auxiliary fuel tanks
5 Transmissions
6 Driving axles
7 Axle drive shaft
8 Electric generators (for cooling fan motors)
9 Lighting and control generators
10 Apparatus cabinets
11 Control stands
12 Handbrakes
13 Air compressors
14 Signal M-G set
15 Steam generator
16 Water tank
17 Heating oil tank
18 Heating control cabinet
19 Signal set control
20 Clothes locker
21 Operator's seats

**Table 2 Diesel Locomotives (Foreign Manufacture)**

| Item No. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Builder—Mechanical | K-M | Krupp | Werks. | Krupp | MCCW | ALS | MIT | B-L |
| Builder—Electrical | — | — | S-H | — | BTH | ALS | MIT | B-L |
| Owner | Ger. Fed. | NW-Braz. | Neth. | Algeria | NSW | Fr. Af. | Japan | SNCF |
| Wheel arrangement | B-B | A1A-A1A | A1A-A1A | B-B-B | B-B | B-B | B-B | B-B |
| Service | F&P | F&P | F&P | F&P | F | F&P | F&P | F-P-S |
| Engine data: | | | | | | | | |
| Engines per cab | 2 | 2 | 1 | 2 | 2 | 2 | 1 | 1 |
| Engine hp rating | 1000 | 950 | 1300 | 550 | 500 | 470 | 900 | 600 |
| No. of cylinders | 12 | 8 | 10 | — | 12 | 12 | 8 | 6 |
| Bore and stroke, in. | 7.28 × 7.9 | 8.7 × 11.8 | 9.45 × 14.2 | — | 7 × 7 3/4 | 6 5/8 × 7 7/8 | 9 2/8 × 12 5/8 | 8.7 × 11.4 |
| Engine speed, rpm | 1500 | 900 | 600 | 900 | 1250 | 1500 | 800 | 900 |
| Cycles | 4 | 4 | 2 | 4 | 4 | 4 | 4 | 4 |
| Supercharged | Yes | Yes | Yes | Yes | No | Yes | Yes | Yes |
| Manufacturer | Maybach | MAN | S-T | MAN | Pax. | Saurer | Mitsu | Sulzer |
| Weight on drivers, lb | 170000 | 141000 | 144000 | 163000 | 180000 | 110000 | 140000 | 150000 |
| Total locomotive weight, lb | 170000 | 176000 | 216000 | 163000 | 180000 | 110000 | 140000 | 150000 |
| Fuel capacity, gal | — | 740 | 770 | 1050 | 600 | 610 | 400 | 532 |
| Driving wheel diam, in. | 37 | 37 1/2 | 43 1/4 | 39 3/8 | 42 | 36 7/32 | 39 3/8 | 41 3/8 |
| Type of transmission | Hydra | Hydra | Elec. | Hydra | Elec. | Elec. | Elec. | Elec |
| Track gage, in. | 56 1/2 | 39 3/8 | 56 1/2 | 56 1/2 | 56 1/2 | 39 3/8 | 42 | 56 1/2 |
| Maximum permissible speed, mph | 87 1/2 | 57 1/2 | 62 1/2 | 50 | 57 | 44 | 56 | 50 |
| Fig. No. | 14 & 15 | 16 | 17 | 18 & 19 | 20 | 21 | 22 | 23 |

K-M—Krauss-Maffei—Germany.
Krupp—Krupp Lokomotivfabrik—Germany.
Werks.—Werkspoor—Netherlands.
MCCW—Metropolitan Cammell Carriage & Wagon Works—England.
ALS—Societe Alsthom—France.
MIT—Mitsubishi Heavy Industries—Japan.
B-L—Brissoneau and Lotz—France.
S-H—Smit-Heemaf—Netherlands.
BTH—British Thomson-Houston—England.
Maybach—Maybach Motoren Bau—Germany.
MAN—Maschinenfabrik-Augsburg Nürnberg—Germany.
S-T—Stork-Thomassen—Netherlands.
Pax.—Paxman, Davey & Co.—England.
Ger. Fed.—German Federal Railways.
NW Braz.—Northwestern of Brazil RR.
Neth.—Netherlands State Railways.
Algeria—Algerian State Railways.
NSW—New South Wales Rys.
Fr. Af.—French West African Rys.
Japan—Japanese Government Rys.
SNCF—French National Rys.

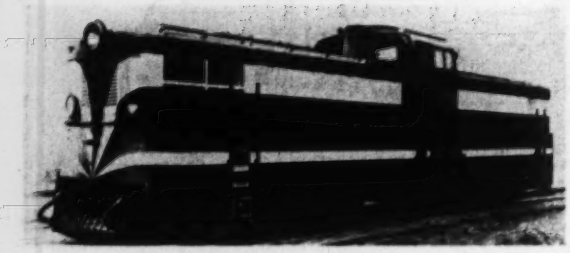

Fig. 16 A1A-A1A 1900-hp diesel-hydraulic locomotive for meter-gage service

of two locomotives under the guidance of a single operator in one operating cab. Total service weight is 88 tons with 70.5 tons on driving wheels. The locomotive was built by Krupp of Germany and is equipped with MAN engines.

The diesel-electric shown in Fig. 17, and described under item 3 of Table 2, employs a 10-cylinder, two-cycle, supercharged engine running at the relatively conservative speed of 600 rpm. Despite the use of this relatively slow-speed engine and an A1A-A1A truck arrangement the total weight of locomotive amounts to but 108 tons, 72 of which is on driving wheels.

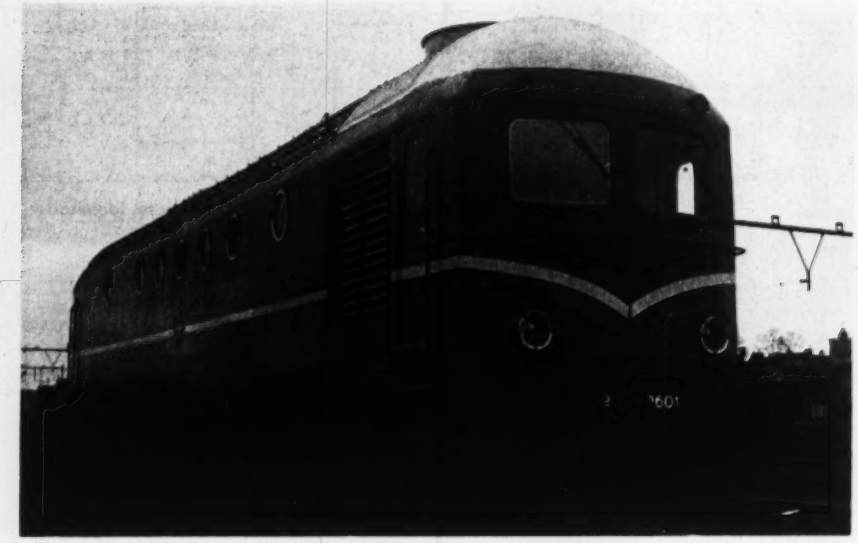

Fig. 17 1300-hp unit for Netherlands Railway

the German locomotive are the high-speed engines and the elimination of electric transmission equipment. The conventional center-plate mounting of the cab structure is missing in the design and the cab weight is carried on off-centered loading pads with a link system arranged to hold the superstructure in properly centered position with respect to the truck vertical axes. Auxiliary electric power is taken from small generators driven from the transmission gearboxes. Radiator cooling fans are electric-motor-driven. A steam generator for train-heat supply is located centrally between the two power plants. The locomotive is built for double-end operation and is practically symmetrical in construction and equipment layout about the center vertical axis.

Additional dimensional data are given in Table 2, item 1.

The meter-gage diesel locomotive shown in Fig. 16, and described under item 2 of Table 2, is notable in that it is probably one of the most powerful single-unit diesel locomotives yet built for meter-gage service. Two engines, totaling 1900 hp, are provided, each driving through a hydraulic transmission to two axles of an A1A truck.

Individual axle drive, with each axle independently driven through hydraulic torque converters, is a feature of this design. Multiple-unit control of engine power through a single air pipe is provided to permit operation

Figs. 18 and 19 illustrate an unusual design of diesel locomotive built in Germany by Krupp in which hydromechanical transmission and individual axle drive are featured. Details of design and equipment layout are shown in the three-part illustration of Fig. 19. The running gear and mechanical structure are unique in that an articulated arrangement for the two parts of the superstructure is employed and carried on the inside ends on the center truck. The individual axle drives through universal joints and Cardan shafts from the two main transmissions are shown in the lower plan view of Fig. 19. All six of the individual axle drives are independent of each other and each has its own hydraulic torque converter—three converters being provided in each of the two main transmission boxes. Two speed stages are provided and the change from one to the other is automatically performed under control of the locomotive running speed. Engine starting is accomplished by means of stored compressed air, and lighting is supplied from two small 24-volt generator-battery combinations, the generators being belt-driven by take-offs from the water-cooling fan drives. The locomotive weighs in service order 82.5 tons and can be arranged for service on track gages between meter and standard $56\frac{1}{2}$ in. Dimensional data are shown in millimeters in Fig. 19, and in English units under item 4 of Table 2.

Fig. 20 and item 5, Table 2, describe a double-engined

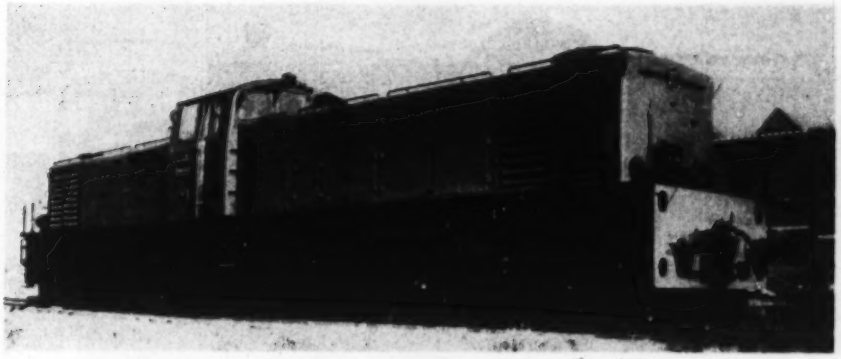

Fig. 18 Articulated-cab B-B-B unit for Algeria

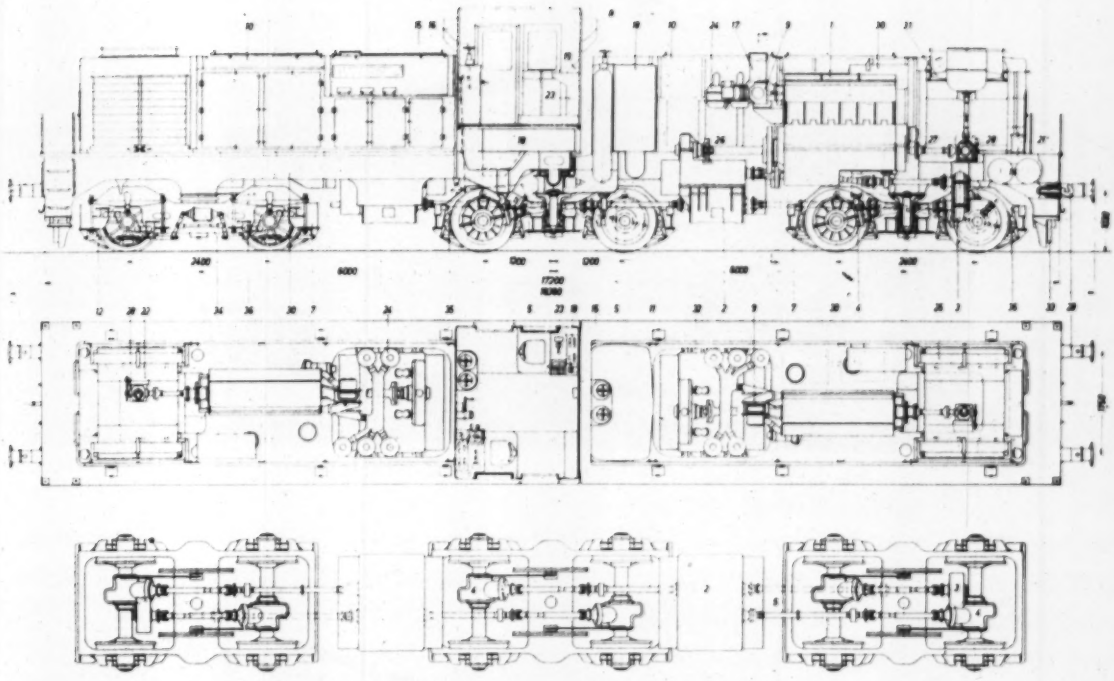

Fig. 19 Sectional views of unit shown in Fig. 18

1 Diesel engine
2 Main transmission gear
3 Intermediate gear
4 Axle drive
5 Driving and intermediate shafts
6 Frame
7 Bogie
8 Driver's cab
9 Gas turboblower
10 Engine compartment
11 Sandbox
12 Sanding pipe
13 Screw handbrake
14 Brake air reservoir
15 Starting air container
16 Window plate
17 Exhaust
18 Fuel tank
19 Instrument panel
20 Speedometer
21 Battery
22 Lighting dynamo
23 Control table
24 Air filter
25 Cooler
26 Elastic clutch engine—transmission
27 Elastic clutch engine—fan
28 Fan gear
29 Draw and buffer gear
30 Water tank
31 Fan
32 Compressor
33 Cow-catcher
34 Brake cylinder
35 Brake block
36 Bearing spring

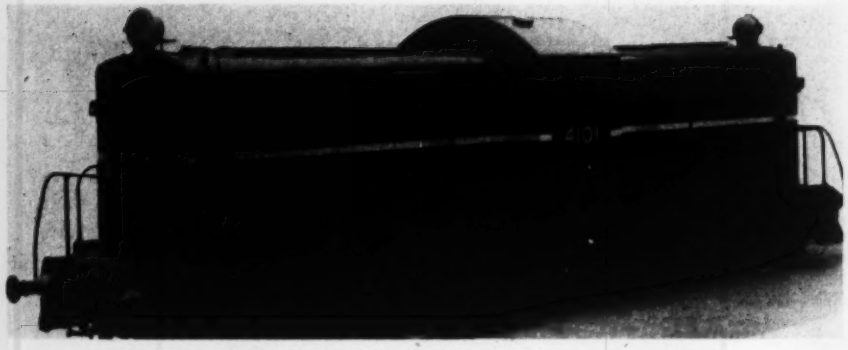

Fig. 20 English-built unit with high-speed nonsupercharged engines

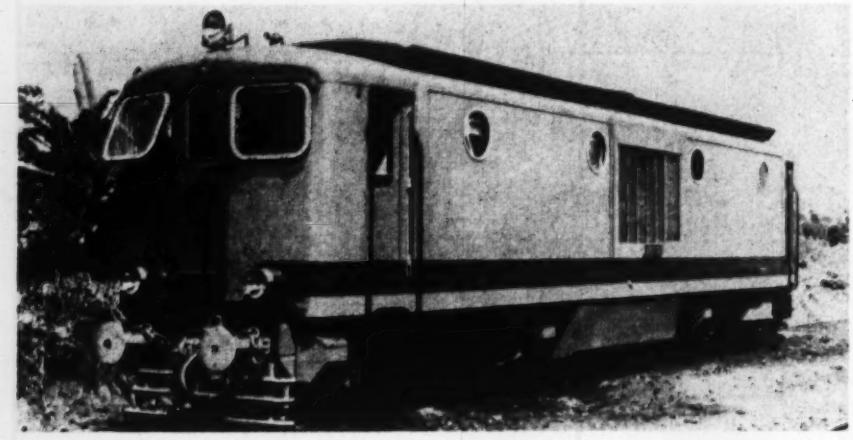

Fig. 21 Lightweight double-engine unit for French West Africa

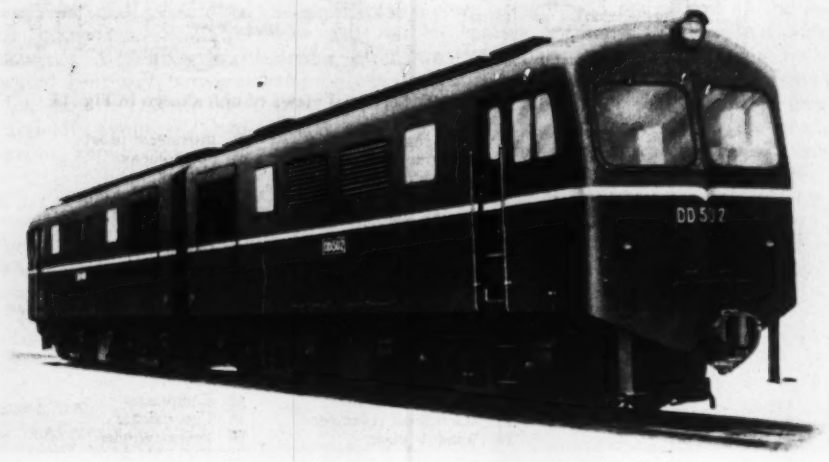

Fig. 22 Japanese railway locomotive built by Mitsubishi

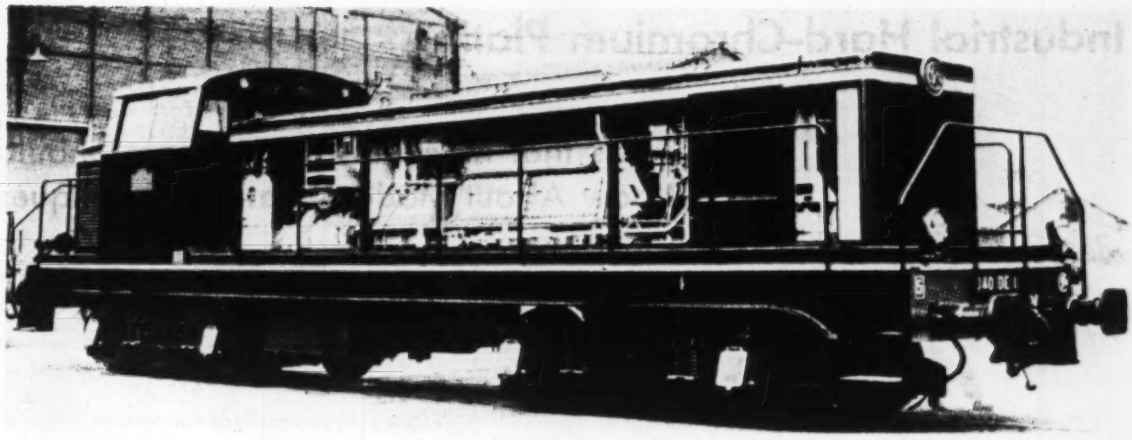

Fig. 23 New French standard all-purpose unit

locomotive with a total rating of 1000 hp. Naturally aspirated engines running at 1250 rpm are employed. The total weight of 90 tons is noteworthy for the installed power in view of the fact that two nonsupercharged engines are employed.

The locomotive shown in Fig. 21 and described as item 6 in Table 2 is in itself not unusual except for the inclusion of two high-speed engines with a total horsepower of 940 in a locomotive weight of 55 tons. The trend to higher horsepower secured by the use of high-speed engines is evident in this design.

A Japanese diesel-electric double-unit locomotive rating 900 hp per cab in a single-engine design is shown in Fig. 22 and described under item 7 in Table 2.

A new French standard diesel-electric for freight, passenger, switching, and humping service is shown in Fig. 23, with over-all appearance conforming strikingly to American practice. Item 8 of Table 2 gives particulars about the unit. Special control features enable the unit to work in humping service at low locomotive speeds, high tractive effort, and reduced engine speeds.

While relatively small in physical dimensions and power, the two-power switchers operated by the Swiss Federal Railways, and shown in Fig. 24, are noteworthy in that the diesel engine (90 hp) is of an air-cooled type. The locomotive is arranged to operate from the 15 kv, $16^2/_3$ cps, single-phase contact system, or under its own power as a diesel-electric. Because of commutator limitations characteristic of a-c series-wound traction motors during starting, it has been found practicable to utilize the diesel-generator set for starting heavy trains, switching over to a-c operation only after the train has been brought up to speed. The unit weighs approximately 16 tons and has a starting tractive effort of 6700 lb and a top speed of 25 mph.

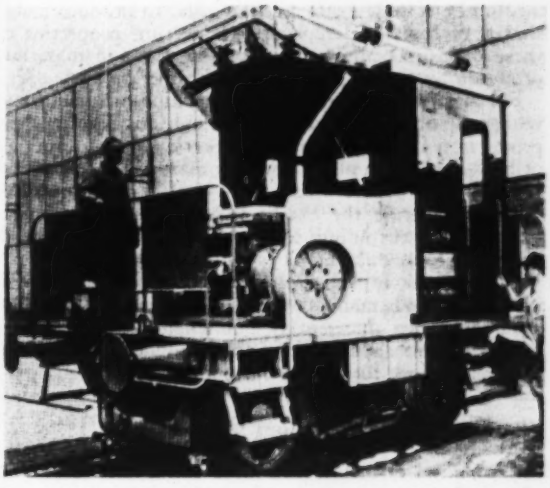

Fig. 24 Two-power locomotive operating on Swiss Federal electrified railways

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*(To be continued in April)*

# Industrial Hard-Chromium Plating

## Facts that Mechanical Engineers Should Know About Modern Plating Techniques

**By Warren Schmidt[1] and William E. Hogan[2]**

**City Plating Works, Inc., Bridgeport, Conn.**

ENGINEERS are likely to think of electroplating as a chemical finishing process, whereas recent developments have elevated the art to a point which demands recognition of the fact that in addition to their use as a cover medium, electrodeposits are now used to produce metal shapes of high fidelity; the engineering properties of these deposits being comparable to those of materials produced by casting and mechanical operations.

For design engineers in the machine-tool industry, where the objectives are accuracy and long life for their products, a knowledge of the properties and performance of hard-chromium plate is vitally essential. An inspection of some of the recent high-quality machine tools will demonstrate the extent to which some engineers have utilized chromium to prevent wear on parts which control accuracy and on parts which enhance the appearance and sales appeal of their machines. This trend is increasing and manufacturers in other fields, where accuracy is not an essential, but where long useful life and attractive appearance of the products are essential, are increasingly turning to chromium.

### Characteristics of Chromium

Chromium is one of the more stable metals and its physical properties practically make it the most stable for engineers. Some of these properties are given in Table 1.

Because of the inherent brittleness of chromium which is similar in this respect to tungsten carbide, the best results are obtained when the supporting base metal is also hard. It is obvious that a comparatively soft base will not support adequately a brittle, plated surface which is subjected to deforming pressure, such as a blanking-die operation. Hardened steel and chilled iron are most suitable base metals, but other metals likewise prove satisfactory, depending upon the purposes for which the plated parts are to be employed. Fig. 1 shows to the Mohs scale the comparative hardness of metals including metallic chromium. The base of the Mohs scale is 10.

Electrodeposited chromium, however, varies in hardness depending upon the method pursued in the plating procedures, technical knowledge, experience, plating facilities, and the equipment employed.

Chromium is comparatively gall-proof, is non-magnetic, and has an electric conductivity of 16 as compared with silver at 100, copper at 97.67, and aluminum at 63.

**Table 1 Properties of Chromium**

| | | | |
|---|---|---|---|
| 1 | Approximate hardness values: | | |
| | Rockwell C scale | | 65–70 |
| | Brinell (10-mm ball 3000 kg) | | 682–760 |
| | Mohs' scale—diamond | | 10 |
| | Mohs' scale—chromium | | 9 |
| 2 | Approximate comparative values of abrasion or wear resistance: | | |
| | Silver | | 4 |
| | Hard nickel plate | | 59 |
| | Bright chromium plate | | 500 |
| | Chromium is superior to nitrided steel | | |
| 3 | Approximate heat-resistance data: | | |
| | Chromium discolors at (deg F) | | 1100 to 1470 |
| | Oxidizes at (deg F) | | 1830 |
| | Melts at (deg F) | | 2939 to 3325 |
| | Example: Is used on airplane-engine exhaust manifolds | | |
| 4 | Comparative coefficients of friction: | | |
| | | Static | Sliding |
| | Steel on babbitt | 0.25 | 0.20 |
| | Steel on chromium-plated steel | 0.17 | 0.16 |
| | Chromium-plated steel on babbitt | 0.15 | 0.13 |
| | Chromium-plated steel on chromium plated steel | 0.14 | 0.12 |
| 5 | Corrosion-resistance data: | | |
| | Chromium is dissolved by hydrochloric (muriatic) acid and to a minor degree by warm sulphuric acid, but resists most other acids. It resists most alkalies, gases, and complex materials. | | |

### Development of Chromium Plating

It is well known that the electrodeposition of one metal upon the surface of another is accomplished for the purpose of giving to the latter some characteristics which it lacks but which are contained in the plating metal. The history of plating is long but, from an industrial standpoint, begins in the middle of the nineteenth century with the design and development of the electric generator with its plentiful supply of cheaper and more dependable electric power.

The use of chromium as a commercial plating material began in the period from 1924 to 1930, and its industrial applications started following the publication of the results of tests of its use on plug gages by the National Bureau of Standards.

In the plating industry, the terms, "decorative chromium" and "hard chromium," are used extensively. The former usually means a plate of 0.0001 in. thickness or under, generally deposited over nickel plate, and the latter means a plate greater than 0.0001 in. thickness and ordinarily deposited directly upon the base metal.

[1] President, City Plating Works, Inc. Mem. ASME.
[2] Sales Engineer, City Plating Works, Inc. Mem. ASME.

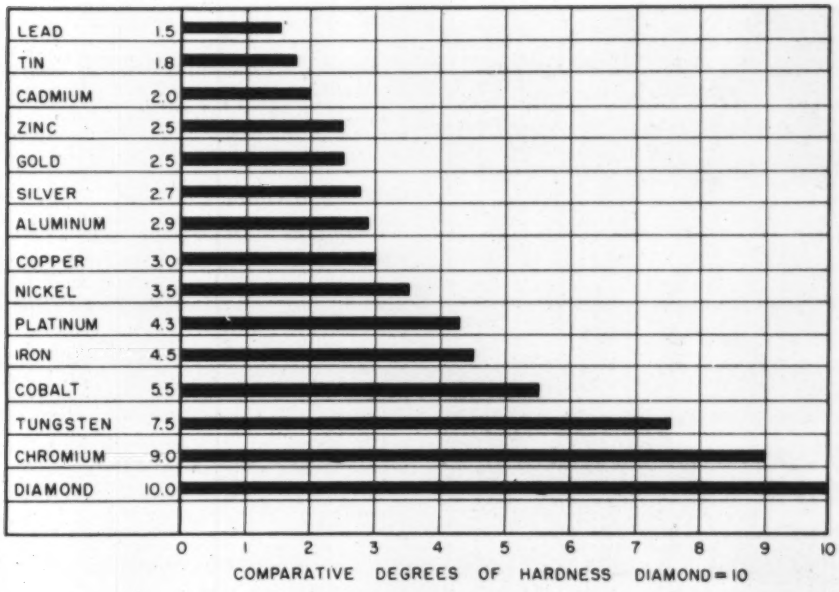


**Fig. 1 Mohs' hardness scale**

"Precision hard-chromium plating," as the term implies, means the application of a plate of uniform, specified thickness to a surface of a part. This operation requires careful design of the plating anodes so as to apply the electric current uniformly to the designated surfaces, accurate timing of the period during which the plating operation is continued, and skilled experienced operators to check the plate thickness as it approaches the specified value. Regular deposition of chromium requires 1 hr to apply 0.001 in. thickness of metal or 6 min to deposit 0.0001 in.

### Specifications for Engineers

Designing and production engineers are mainly interested in precision plating, and from them, the plater should be supplied with such information as the composition of the metal to be plated, its hardness, and whether hydrogen embrittlement has been or is to be relieved. From the production engineer who expects plated parts of uniformly accurate dimensions, the plater should receive parts which have been machined to uniform dimensions. If a bright smooth plate is desired, the machined or ground surface which is to be plated should be smooth. Rough surfaces on the base metal are always reflected in the plated surfaces since chromium plate minutely follows the surface upon which it is deposited. It will not fill low spots and it tends to accentuate burrs and build-ups on edges. For this reason, comparatively heavy chromium-plating of threaded parts is likely to be unsatisfactory unless a subsequent operation of grinding is performed on the threads to remove the excess plate.

Chromium plate does not throw readily into cup-shaped cavities or into holes. Consequently, special conforming shaped anodes must be designed to fit into such places in order to increase the throwing power of the solution and thus secure a satisfactory uniform plate.

### Advantages of Plating

Engineers are naturally interested in anything that maintains the accuracy, extends the life, and reduces the cost of their products. One avenue of approach to their goals is the use of hard-chromium plating, among the outstanding characteristics of which are its hardness and its resistance to abrasion and corrosion.

Because of these characteristics, tests, engineering reports, and experience have demonstrated that chromium-plated plug gages outwear the finest hardened tool steels by from 2 to 19 times. The original cost of such gages can be reduced greatly by the use of cheaper base metals such as drill rod or 1010 steels in place of expensive hardened tool steels.

**Table 2 Comparison Between Chromium-Plated and Unplated Parts**

| | Times increase |
|---|---|
| General machine parts | 2 to 25 |
| Cutting tools | 1.5 to 10 |
| Molds and dies for nonmetallic materials | 3 to 11 |
| Metal-drawing and finishing dies | 2 to 40 |
| Calender rolls | 5 to 17 |
| Embossing rolls | 4 to 18 |
| Cold-rolling sheet-metal rolls | 2 to 5 |
| Textile rolls | 6 to 100 |
| Printing rolls | 2 to 20 |

Comparisons of the life of other chromium-plated to unplated parts are given in Table 2. These data are taken from "Information Release No. 4" of the War Metallurgy Committee of the National Academy of Sciences—National Research Council. That report demonstrates the fact that chromium plating not only produces longer life on parts but also reduces the manufacturing cost considerably on most applications.

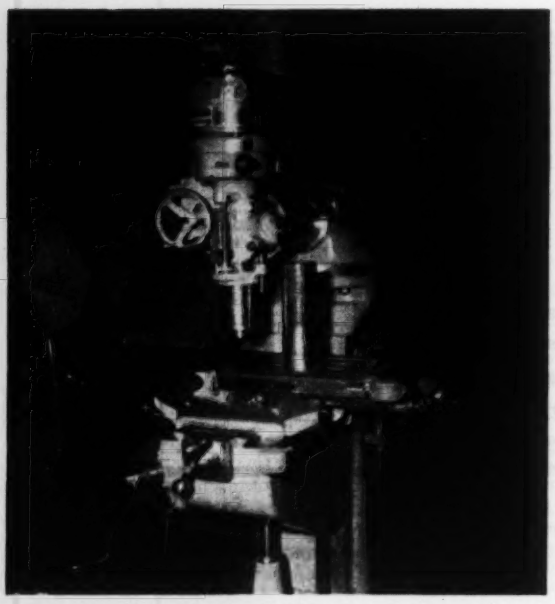

**Fig. 2 Chromium-plated steel "quill" shown on table of a milling machine**

### Resistance to Abrasion

Abrasion resistance of chromium plate is the result of its friction-freeness and hardness. An example of this feature is furnished by the chromium-plated steel "quill" of the milling machine, manufactured by Bridgeport Machines, Inc., Bridgeport, Conn. Fig. 2 shows a quill on the table of a machine. This company has been chromium-plating its quills since 1936, and their perfect performance is attested universally. The quill operates in a cast-iron housing. Initially, it is strain-relieved in the tubing form, but is not heat-treated to secure hardness or temper. A chromium plate of 0.007 in. thickness is applied, and then ground to a finished thickness of 0.004 in. Among the machines which have been returned to this company for repair or rehabilitation, it has never found a quill which required replating as a result of wear.

Another example of precision hard-chromium plating is offered by the 7-in-diam × 75½-in-long, SAE 1045 steel, rams on the "Cutmaster" and "Man-Au-Trol" lines of machine tools built by the Bullard Company, Bridgeport, Conn., Fig. 3. These rams are finish-ground, before plating, to a diameter of 0.002 in. under the final dimension. A precision plate of 0.001 in. plus or minus 0.00005 in. thickness is applied. No grinding, polishing, honing, or buffing operation is performed on the plate after the ram is removed from the plating solution. The piece is ready for assembling in its cast-iron housing.

In order to meet the specified dimensions and to maintain these tolerances, regular tank anodes are employed but the ram is rotated in the plating solution at a uniform slow speed by means of a motor, a geared speed-reducer, and a chain drive mounted on the holding fixture of the ram, all of which are out of the solution except a portion of the chain.

Upon parts, such as the ways of machines, conforming anodes are required to obtain this degree of accuracy. For the benefit of those who are unfamiliar with plating techniques, a conforming anode is one which is built to approximate the shape of the part to be plated and is designed to supply the electric current uniformly to all surfaces of the part.

### Grinding of Chromium Plate

Bridgeport Machines, Inc., after years of extensive research in grinding procedures on its hard-chromium-plated quills, including the new quill on a larger-model machine, has standardized its grinding operations on chromium as follows: Norton grinders, types C 6 × 30 and C 10 × 48, are used on all chromium grinding. A Norton, 38A60K5VBE wheel, 2 in. wide, and a Cincinnati 2A80K5VN are the only wheels used at the present time. The coolant used is Cimco S-2 mixed 40 to 1.

On the quills, the wheels are run at the recommended wheel speeds, depending upon the diameter, and they remove approximately 0.001 in. of stock per pass in roughing. The rate of table feed in general use varies with the type of arbor employed on the work. In general, the grinder table is run slowly, on an average of 30 ipm for both roughing and finishing. After roughing, the wheel is dressed and the finish-grinding of the last 0.001 in. of chromium is accomplished by removing 0.0002 to 0.0003 in. of metal per pass for the purpose of truing and of obtaining the exact size. The tolerances on the quills are 0.0001 in. for straightness and 0.0001 in. for diameter, with a root mean square (rms) of 3 to 5 microinches, as secured by a profilometer, for the surface finish.

Comparative degrees of surface finish in root mean square microinches on some other well-known parts are given in Table 3.

**Table 3 Degrees of Surface Finish**

| | Rms (microin.) |
|---|---|
| Rough-ground crankshafts | 50 |
| Finish-ground crankshafts | 16 |
| Finish-ground tappet heads | 6 |

NOTE: Surfaces ground exceptionally fine, including so-called superfinishes, have (rms) microinch values of 2 to 11.

### Cost Reduction by Chromium Plating

This chromium-grinding procedure, by one of the pioneer users of hard-chromium plating, illustrates the cost-reduction possibilities of precision plating as compared with an alternate method of processing (Table 4).

In addition to the lower first cost of the quill by the employment of chromium plating, this method eliminates the dangers of growth and warpage in the carburized steel, which would add unsatisfactory service and increased maintenance costs.

Manufacturers of commercial products are utilizing precision-chromium plating as illustrated by the brake on a well-known washing machine. The brake shoe, which operates against a composition brake lining to stop the spinner-drier basket automatically in a matter of seconds, is precision-plated to the specified thickness of between 0.0004 to 0.0007 in. by means of accurately

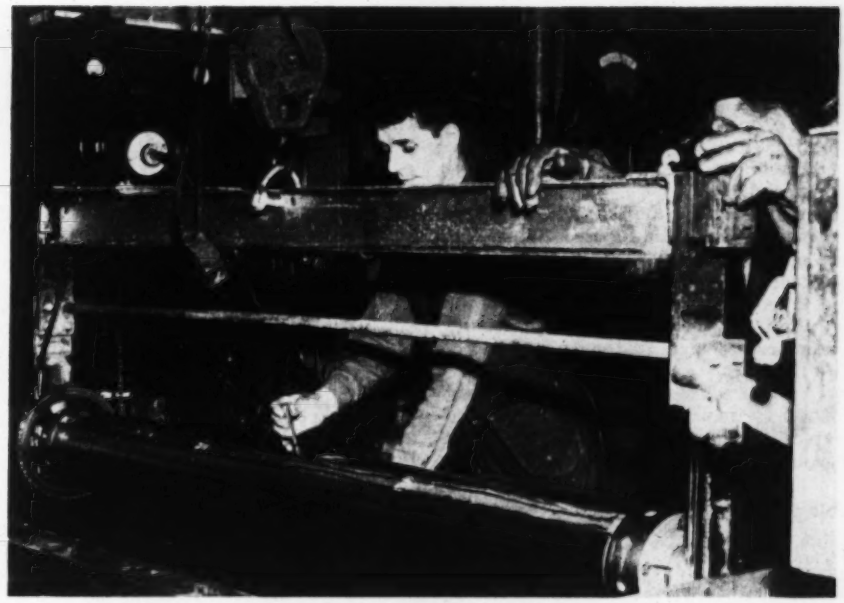

**Fig. 3 Precision-chromium-plating a machine-tool part**

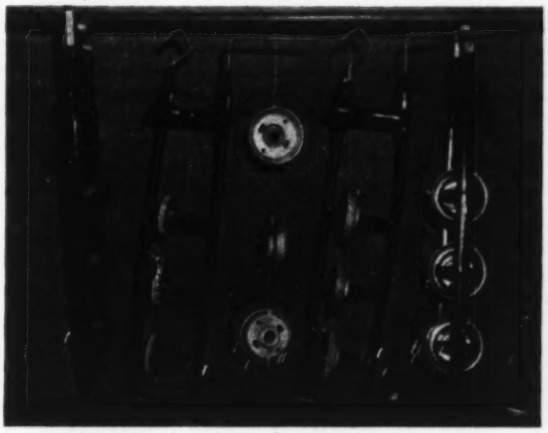

**Fig. 4 Precision-hard-chromium-plated brake shoes**

positioned conforming anodes, Fig. 4, and insures trouble-free operation and long life.

The gun barrel of one of our most popular rifles is precision-ground and precision-chromium-plated in one essential area.

### Other Cost-Reduction Possibilities

Production engineers are vitally interested in reducing tool maintenance, replacements, and costs. This can be done by chromium plating, when new, such tools as taps, drills, reamers, broaches, counterbores, countersinks, mandrels, lathe centers, thread-chasers, files, milling cutters, spinning tools, and knives. Precision-chromium-plated for 60 to 120 sec, they receive a plate thickness of 0.000016 to 0.000032 in. which extends their life, not only because of the hardness of the plate but also because of the reduction of friction and the failure of other metals to stick or weld to chromium at high pressures and elevated temperatures.

This latter property is especially evident in cutting nonmetallic materials such as plastics, slate, hard rubber, and nonferrous metals, such as brass and aluminum, as

**Table 4 Cost Reduction With Hard-Chromium Plating**

| | Procedure and cost without chromium plating | |
|---|---|---|
| 1 | Rough machine | $ 2.60 |
| 2 | Carburize with no quench to 25–30 Rockwell C by heating to 1650 F in gas furnace for 5 hr. Part cooled slowly in furnace | 0.60 |
| 3 | Complete machining | 6.00 |
| 4 | Heat-treat | 0.65 |
| 5 | Finish-grind OD | 2.50 |
| 6 | Finish-grind ID | 7.50 |
| 7 | Lap and fit | 4.00 |
| | Total cost | $23.85 |

| | Procedure and cost with chromium plating | |
|---|---|---|
| 1 | Rough machine | $ 2.60 |
| 2 | Strain relieve at 800 to 1200 F in electric recirculating furnace. Cool in air after reaching temperature | 0.25 |
| 3 | Finish-machining and grinding | 4.50 |
| 4 | Hard-chromium plating (67 Rockwell) | 3.85 |
| 5 | Finish-grind plated surface | 2.75 |
| 6 | Lap and fit | 4.00 |
| | Total cost | $17.95 |

well as cast iron and stainless steel. In practically all cases, the tools should receive a low-temperature heat-treatment after plating to relieve stresses. A common practice is to boil the parts in oil for several hours before and after plating.

Since only a surface property is involved, it is not necessary to use high-alloy steels as a base for these tools. The most satisfactory choice appears to be a tough, low-alloy, oil-hardening steel.

The cost of chromium-plating tools is comparatively low since general purpose racks can be used and special racks usually need not be designed.

The tank time for such thin plate as is used on new plug gages, honed and lapped to size, is very short, but for salvage work on worn gages which have been ground undersize to take a heavier plate, a longer time is required and the cost is higher.

Table 5 gives a current schedule of prices for plating gages in lots of 25 or more that might be termed approximately typical of the Connecticut area. These gages are finish-ground and lapped after plating.

**Table 5 Gage-Plating Costs**

| | |
|---|---|
| Up to 1/4 in. diam, incl | $0.60 |
| From 1/4 to 1/2 in. diam, incl | 0.80 |
| From 1/2 to 1 in. diam, incl | 1.00 |
| From 1 to 2 in. diam, incl | 1.50 |
| From 2 to 3 in. diam, incl | 2.00 |
| From 3 to 4 in. diam, incl | 2.50 |
| From 4 to 5 in. diam, incl | 3.00 |
| From 5 to 6 in. diam, incl | 3.50 |
| From 6 to 7 in. diam, incl | 4.00 |
| From 7 to 8 in. diam, incl | 4.50 |
| From 8 to 9 in. diam, incl | 5.00 |
| From 9 to 10 in. diam, incl | 5.50 |

NOTES:
Double price on double-end gages.
Ring gages 2 times plug gages.
50 per cent extra on square gages.
20 per cent extra to strip old plate.
Each diameter considered a gage.

### Other Recommended Uses of Chromium Plating

In molding synthetic resins, chromium plate has found wide acceptance on the molds because it resists attack by the phenol of the bakelite types, the urea of thio-urea resins, the combined nitric acid of cellulose-nitrate synthetics and the vinyl chloride and acetate of the vinylites. For this reason, the mold retains its original polish and permits easy release of the molded object.

Chromium plating is advantageous in vulcanizing rubber, because it resists attack by sulphur, prevents sticking during the operation, and reduces tool costs. Its use on dies and molds in the production of abrasive clay products displays notable advantages.

Mainly because of its low coefficient of friction, chromium plate has been used widely on a variety of metal-forming dies and mandrels. Its surface is hard and slippery and prevents galling and welding. A thickness of plate of 0.0002 to 0.001 in. is fair for most applications.

The effects of chromium plating on dies as recorded in the War Metallurgy Committee's "Information Release No. 4" are shown in Table 6.

When a mold has to be reground to remove scratched and worn sections, it is common practice to strip the old chromium, repolish, and precision-plate to compensate for the base metal removed.

Hydraulic pistons, such as those in pumps, are usually given a plate of 0.005 in. thickness, but, occasionally, as much as 0.010 in. is required. These pistons often operate against a long-hemp type of packing and the edges have to be wire-thieved on such heavy deposits.

Cast iron may be chromium-plated but, owing to its high electrical resistance, it requires special handling. This consists of applying 6 times the normal electric current used in plating for a short time at the beginning of the plating operation in order to secure a conducting surface of chromium, and then reducing the current value to normal strength.

On large cast-iron rolls, this operation is often impractical because of limitations of the capacity of the plating generators or rectifiers.

**Table 6 Effect of Chromium Plate on Dies**

| Application | Service | |
|---|---|---|
| | Unplated | Plated |
| Swaging carriage bolts | 200000 pcs | 500000 pcs |
| Forging a tube thimble | 9000 pcs | 22000 pcs |
| Shearing laminations | 50000 pcs | 391250 pcs |
| Ring for coining die | 200000 pcs | 600000 pcs |
| Swaging wire | 4 hr | 52 hr |
| Swaging rivets | 3000 pcs | 24000 pcs |
| Pressing stainless steel | 25 pcs | 250000 pcs |
| Blanking and drawing stainless steel | 500 pcs | 20000 pcs |
| Blanking and forming No. 1 | 700 per hr | 2000 per hr |
| Blanking and forming No. 2 | 300 per hr | 7000 per hr |
| Coining | 1 week | Several months |
| Drawing | 4000 pulls | 75000 pulls |
| Forming | Each time | 8 times |
| Cold heading | Each time | 6 to 20 times |
| Stamping brass | Each time | 3 times |
| Mandrel for hard tubing | Each time | 10 to 15 times |

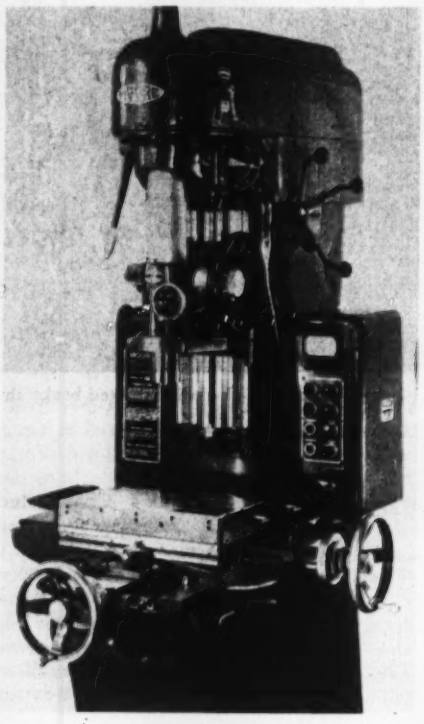

Fig. 5 More than 80 velvet-chromium-plated parts are used on jig borer

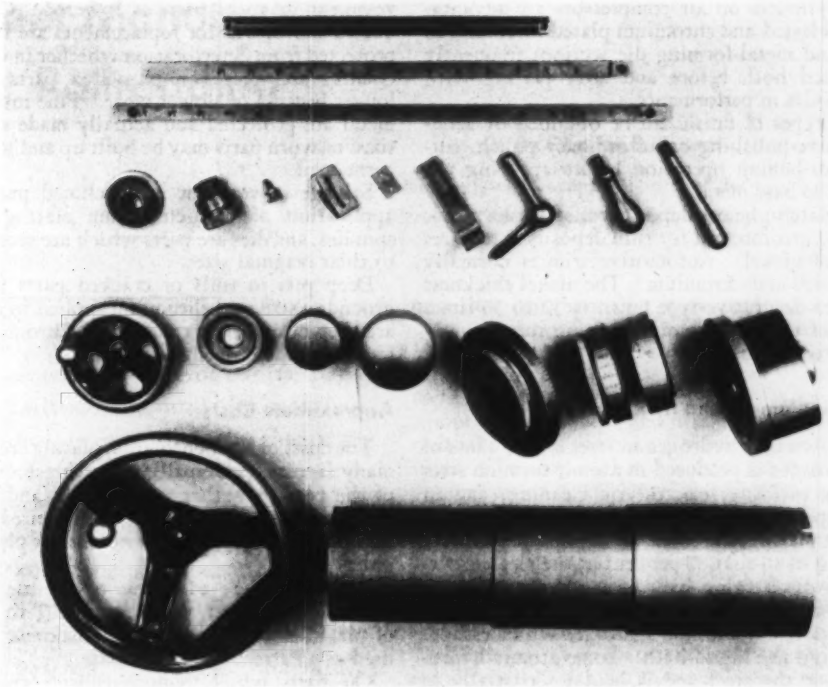

Fig. 6 Plated parts of jig borer include iron, several grades of steel, aluminum, and brass

Chromium can be plated upon most other metals including certain alloys of aluminum and magnesium. With the increasing use of these lighter and softer metals, chromium plate provides a means of adapting them to numerous applications where light weight combined with wear resistance are required.

Aircraft engineers constantly are seeking new ways to lighten their product and increase horsepower per pound. Parts formerly made of steel to meet wear and abrasion-resistance can now be made of chromium-plated aluminum, thus adding more horsepower per pound and eliminating rusting problems, the bugaboo of aircraft in operation.

An outstanding example of chromium plating on aluminum is the core box for making sand-blown cores. Aluminum is an excellent material for machine parts of irregular contours and intricate cavities, and the coremaker can handle large sizes without using hoisting equipment. Hard-chromium plating the faces of these boxes increases their life indefinitely. A $500 box usually costs $2000 in repairs unless there has been an engineering change, so that practically all of the $2000 is saved. Foundry patterns constitute a big field for this new combination of metals. Where light weight and a bright, tarnish-resistant surface are sought, such as in fishing reels, cooking utensils, metal furniture, and so on, chromium-plated aluminum is the answer.

As has been stated previously, chromium plate has found a use in application to external showy parts of machine tools to enhance their appearance and increase their sales appeal. Among these parts are handwheels, dials, inch-scales, and the like. The potential plating of this type of part may be appreciated more readily when it is realized that upon one model jig borer, on the market today, over 80 parts are chromium-plated.

As normally deposited, this plate is very bright and highly reflective. These characteristics are sometimes objectionable to the machine operator because of the glare from reflected light.

### Effects of Vapor-Blasting

Without affecting the other characteristics of the chromium plate, it can be vapor-blasted (otherwise known as liquid-honed) to produce a blue-velvet or a silver-velvet type of finish. The blue-velvet finish is obtained by vapor-blasting the deposited chromium plate while the silver-velvet is obtained by vapor-blasting the parts before they receive the plate. The former is the duller but both finishes prevent reflection and glare.

The jig borer of the Moore Special Tool Company, Bridgeport, Conn., shown in Fig. 5, has over 80 parts which are velvet-chromium-plated. These parts are of iron, various grades of steel, aluminum, and brass. A few of them are shown in Fig. 6.

The sersations or graduations and the numerals on dials and scales are brought out prominently by applying a special, chromium-adherent, red or black paint to the finish-plated surfaces and then removing the excess paint with a soft cloth. The paint remaining in the markings, hardens quickly and lasts indefinitely.

Vapor-blasting before plating also improves plate adhesion and its resistance to shock and wear. Cutting edges on tools are vapor-blasted before plating to increase their useful performance.

Aluminum cylinders on air compressors are advantageously vapor-blasted and chromium plated internally to resist wear; and metal-forming die sections frequently are vapor-blasted both before and after plating with outstanding results in performance.

Many other types of finish can be obtained by sand-blasting, abrasive-polishing or an ordinary polish, cut-down and color-buffing operation before applying the chromium on the base metal.

Chromium plate in heavy deposits resists atmospheric and salt-spray corrosion, but for thin deposits it requires an undercoat of nickel. Automotive trim is normally plated with nickel and chromium. The nickel thickness on this so-called decorative-type finish is 30 to 50 times the thickness of the chromium which, in turn, is only plated about 1 to 3 min.

### Hydrogen Embrittlement and Its Removal

It is well known that hydrogen in steel causes a loss of strength. Hydrogen is produced in atomic form on steel surfaces during pickling, electrolytic cleaning, and in most plating operations.

In chromium plating, the efficiency of deposition rarely exceeds 20 per cent so that 80 per cent of the electric current is used in discharging hydrogen. However, most of this atomic hydrogen combines at the surface of the metal to form gaseous molecular hydrogen which escapes by rising through the liquid bath. Some atomic hydrogen diffuses into the steel and is held interstitially in the metal lattice, but the solubility of molecular hydrogen in iron is exceedingly small and when the plating operation ceases, the atoms of hydrogen leave the lattice and combine instantly to produce hydrogen gas.

Molecular hydrogen may be trapped at grain boundaries, slag inclusions, microscopic rifts, slip planes, or at the interface between the steel and the chromium plate. The pressure of the hydrogen may be very high, even exceeding the elastic limit of the metal. Embrittlement, therefore, probably results from the strain imposed by the occluded hydrogen and its effect is a decrease in the resistance of the metal to shock or bending. This is especially noticeable in parts with large surfaces relative to their volume, such as springs, wire, and needles.

In general, embrittlement is more severe for hardened steels and increases with the thickness of the plate, but most of the hydrogen may be removed and the impact strength restored by heating the material. Gernet reports that chromium begins to evolve hydrogen in vacuo at 275–302 F and that most of the gas is eliminated below 662 F. The hardness of chromium remains unaffected by such temperatures, and the wear resistance remains unchanged or may actually increase.

Hydrogen embrittlement tends to dissipate itself at room temperatures but is hastened by heating. The oven temperature specified on many common types of steel is 350 F plus or minus 25 deg F for 3 hr.

### The Value of Chromium Plating

In most all applications of chromium plating, the life of the plated parts is extended from two to many times its unplated life. If replated before the chromium is completely worn through, a part may be plated and restored to its original condition. Removal and replacement of machine parts is less frequent and usually much less expensive. Maintenance expense is reduced. Investment in spare parts is lowered. Operating delays due to shutdowns for replacements are fewer. Parts are protected from deterioration whether in use or in storage. Quality and precision of plated parts are maintained longer because of slower wear. Fine intricate designs in metal are protected and actually made sharper. Undersized or worn parts may be built up and made more nearly permanent.

Salvage of worn or mismachined parts is a frequent application of hard-chromium plating. Shafts, rolls, spindles, and dies are parts which are most easily restored to their original sizes.

Deep pits in rolls or cracked parts may be welded, ground to size, and chromium applied to the parts, which are then often better than new. Chromium can be satisfactorily plated over chromium.

### Approximate Costs

The costs of hard-chromium plating are dependent upon many factors, principally upon the shape and condition of the parts, whether special racks and anodes must be designed, the thickness of plate required, the amount of masking necessary, and the number of pieces in any given order.

If the parts are adaptable to the use of simple racks which are on hand, a price of $0.02 to $0.06 per sq in. of plated surface per 0.001 in. thickness of plate may be used as a current rough estimate.

On parts which require considerable masking, the masked area is counted as if it were plated and is priced accordingly.

When special racks and anodes must be designed, the cost of building this equipment must be absorbed in the job cost, but a lower price is charged on subsequent jobs, since the racks and anodes are available from the first job.

Heavy plates which require 1 hr per 0.001 in. thickness of plate are higher priced since they require considerable tank time, a factor in the plater's pricing formula. For subsequent grinding a plate of 0.010 to 0.015 in. is often used. A 0.050-in. plate can be deposited.

The sizes and weights of parts which may be chromium-plated are almost limitless.

In the plant with which the authors are associated, the limits are 30 in. diam, 140 in. length, and 2 tons in weight; but another Connecticut plant, which is probably the largest in the country, is equipped to handle parts up to 24 ft diam and 20 tons in weight.

In this article, the authors have endeavored to condense some of the information, data, and costs on industrial hard-chromium plating which engineers and manufacturers will find of value in their work, together with illustrations of a few of the many applications which are in use today.

New developments and applications are being perfected constantly, however, and it is suggested that mechanical engineers who have been interested enough to read through this article and who want to keep abreast of such developments consult the electroplating and metal-finishing trade journals.

### Acknowledgment

For data concerning the finishing of quills the authors are indebted to Mr. Edward T. Kiernan, plant superintendent of Bridgeport Machines, Inc.

# The Wheel Manufacturer Looks at Railroading

By Charles B. Bryant

Chief Engineer, Technical Board of the Wrought Steel Wheel Industry, Chicago, Ill. Member ASME

**This paper describes the functions performed by railroad-car and locomotive wheels and points out that the heating action of brake shoes is the most severe of the various service requirements. Figures are given indicating the effects of equipment design and railroad operating practices as they have changed and developed in recent years. The mechanism by which brake-shoe heating produces harmful effects on wheels is described, and suggestions are made for minimizing them.**

THE subject of wheels is far from a static one. Great changes have occurred in service requirements for wheels which have been brought about by advances in the design of railroad equipment and in the methods of operation adopted by the railroads in recent years. In general, railroad-service conditions have become more difficult as speeds have increased. However, it is doubtful that many have had the opportunity to evaluate the degree to which these changes have imposed increasingly severe demands on wheels.

Attention is called to the fact that a railroad wheel not only performs the function of carrying the load of the equipment and, by means of the flanges, keeps it on the track, but (except for cars with disk brakes) it also acts as a brake drum to dissipate the kinetic energy of the equipment in stopping and in controlling the speed on descending grades. The wheel producer thus not only has externally applied mechanical forces to keep in mind, but also must provide for dissipating as heat the large energy values involved in braking.

## Wheel Requirements

Some of these requirements can be illustrated by specific figures. If we go back to prestreamliner days, we find that passenger cars were predominantly what we now call heavy designs. They weighed as much as 190,000 lb and were carried on two 6-wheel trucks. The weight carried by each wheel under such an arrangement is approximately 15,800 lb. When that kind of equipment was built, about 60 mph was considered fast railroading and not many trains ran at higher rates of speed. To stop such a car from 60 mph involved the dissipation of 1,900,000 ft-lb of energy at each of the 12 wheels.

The coming of the streamliner era brought with it so-called "lightweight" passenger equipment. Through improvements in materials and design, the weight of passenger cars has been reduced appreciably and on typical new equipment the weight per car is about 50,000 lb less than that of the prewar car. This lightweight of 140,000 lb, however, rides on two 4-wheel trucks, and each of the 8 wheels carries 18,000 lb. Thus the lightweight car has increased the load carried by each wheel about 14 per cent. Furthermore, speed has been stepped up considerably and 90 mph is no longer unusual. Since the energy of a moving body is proportional to the square of the speed, a 50 per cent increase in speed results in the energy more than doubling. Stopping this postwar car from a speed of 90 mph involves the dissipation of approximately 4,950,000 ft-lb of energy for each wheel, a big difference from the 1,900,000 ft-lb under the old conditions.

Along with the streamliner type of car design, the diesel locomotive has become dominant. Wheel loads under diesel locomotives are considerably greater than the wheel loads under cars and usually are in the range of 26,000 to 32,000 lb on each wheel. Stopping a wheel carrying a 28,000-lb load from 90 mph involves the dissipation of 7,600,000 ft-lb of energy. Comments will be made later on the findings of research in evaluating what these energy values do in the way of developing stresses in wheels. In the meantime, the facts noted here give some idea of the changed service conditions which, in a relatively few years, have become typical conditions on American railroads.

## Passenger-Train Speed Conditions

Some may think that the case is being overstated when a speed of 90 mph is used as an illustration. Here is some information along that line. Not long ago a technical magazine published the results of an analysis of passenger-train operations on American railroads. The study listed all of the trains in the United States which operated at an average speed of 60 mph or more and computed from this the total number of daily miles made by trains in that speed bracket. In 1938, the first year of this 10-year survey, there was a daily mileage at aver-

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age speed of 60 mph or more of 48,000 miles. At the end of the 10-year period, in 1948, that figure had increased to 129,000 daily miles. This survey also included similar studies of operations which averaged 70 mph or more. In 1938 there were 4400 daily miles made by trains which maintained that average speed, and by 1948 the figure had become 14,900 daily miles averaging 70 mph or more. These two comparisons are an index of what has been happening in the high-speed brackets.

The figures require analysis in order to show their full significance. Those who have driven cars on long trips are aware that although the speedometer is held at 60 mph every possible minute, it is extremely difficult to average 45 or 50 mph over a day's driving. Exactly the same principle is true in railroad operations. These 60 and 70-mph over-all average speeds necessarily involve a considerable amount of running at much higher speeds.

A survey has been made, through the co-operation of some of the railroads which have permitted a study of their operating time tables, of the mileage traveled in various speed brackets by passenger trains. An example of one such study follows: This train makes a run of just over 900 miles and the average speed, terminal to terminal, is 57 mph. In order to achieve that average, 22 per cent of the 900 miles is made at speeds between 80 and 90 mph and 15 per cent of the total is made at a speed in excess of 90 mph. In another operation, a shorter run, just under 300 miles, the average speed is 58 mph. The mileage made between 80 and 90 mph is 32 per cent of the total distance and the mileage made in excess of 90 mph is 25 per cent of the total. There are many other similar instances, but these two will suffice to show that 90 mph is no longer an unusual circumstance.

Along with these higher speeds there have been developed improved means of applying brakes. As long ago as 1905, experimental train operations had shown that the adhesion between wheels and rails placed a limit on the braking effort that could be used. It was found that a stop from 60 mph could be made in 1200 ft. As speeds have increased, equipment designers generally have worked on a basis of comparable stopping performance, giving due weight to the square-of-the-speed relationship mentioned previously. This has resulted in braking systems for high-speed operations, capable of stopping trains going 100 mph in 3600 ft.

The coefficient of friction between cast-iron brake shoes and the treads of wheels varies with the speed, being less at high speed than at low speed. As a consequence of this, air-brake systems for high-speed operation are designed to apply automatically a high braking pressure while the train is at high speed and reduce gradually the braking pressure as the speed diminishes. The device by which this graduated control is exercised is called speed-governor control. The aim of this is to take full advantage of the adhesion between the treads of the wheels and the rails and to bring the train to a stop in the shortest possible distance. Thus, not only have the total quantities of energy to be dissipated been stepped up by the equipment design and operating factors previously noted, but the rates at which these augmented energies are dissipated are terrific. To stop a diesel locomotive with wheels loaded to 30,000 lb each from 100 mph in 3600 ft requires the dissipation of energy at the average rate of 415 hp for each wheel over the entire distance of the stop.

### High-Speed Slip

The diesel locomotive has created another new situation for wheels, resulting from the phenomenon known as "high-speed slip." In order to develop peak performance of a locomotive, it is necessary to transmit, through the wheels, the greatest possible tractive effort which the adhesion between the wheels and rails will permit and the equipment is designed with that intention. Thus it is not unusual when an unfavorable adhesion situation occurs, such as wet rail or low joints which temporarily reduce the pressure between wheels and rails, for wheels to start to spin. It will be remembered that the static coefficient of friction between two surfaces is greater than the kinetic coefficient of friction. Therefore, when a wheel starts to slip, if the power transmitted through the wheel is not reduced, the wheel will continue to slip. With a steam locomotive there was never any question as to when the drivers slipped—the roar of the sudden high-speed operation could be heard for a long distance and the engineman immediately closed the throttle and made a fresh start. With a diesel locomotive, however, when the wheels start to slip, no such violent notice is given to the engineman. Instruments have been devised and are installed on most diesel locomotives to warn the engineman by a flashing light that slipping is occurring. If these devices get out of order, and in some cases, even though they are in order, and two pairs of wheels begin to slip at the same time, the engineman has no knowledge that slipping is occurring. When slipping does occur, a large part of the energy being produced by the locomotive is dissipated in the form of heat developed between the spinning wheel and the rail.

Considerable information is available on the occurrence of high-speed slip on diesel locomotives. One large railroad, operating over 1000 diesel-locomotive units, has made an extensive study of this by special instrumentation, providing autographic charts which record the occurrence and severity of wheel slip. This railroad has permitted the author to go over the records of what has been learned. One record, for instance, shows that while a locomotive was moving 3 miles, at an actual speed of less than 20 mph, one pair of driving wheels slipped to such an extent that the tape record of that pair of wheels indicated 19 miles. The rotational speed of the slipping wheels was equivalent to an over-the-road speed of between 50 and 60 mph. Another record disclosed that while the train actually was moving over the track at 80 mph, both axles on one truck of the locomotive slipped at a rotational velocity in excess of 120 mph, the limit of the recording equipment, for a distance of 2 miles.

In another operation, over a track distance of 110 miles, one pair of wheels, according to the tape record which it produced, ran an extra 39 miles, most of which was recorded at the limit of the instrument—120 mph. On another occasion, over a true distance of 77 miles, one pair of wheels ran up a mileage of 128, the velocity of the slip being above the limit of the recording instrument.

The railroads and the diesel builders are becoming increasingly aware of the seriousness of this situation, not only from the standpoint of wheel damage, but because of traction-motor maintenance troubles resulting from excessive centrifugal forces.

### Wheel Facts!

**Each wheel of the two 6-wheel trucks of prewar passenger-car equipment carried a load of 15,800 lb.**

**A lightweight passenger car of the "streamliner" era imposes 18,000 lb on each wheel of its two 4-wheel trucks.**

**To stop a prewar car from 60 mph required dissipation of 1,900,000 ft-lb of energy on each of its 12 wheels.**

**A modern passenger car operating at 90 mph involves dissipation of approximately 4,950,000 ft-lb of energy per wheel.**

**Under diesel locomotives, wheel loads range from 26,000 to 32,000 lb per wheel. Stopping a wheel carrying a 28,000-lb load from 90 mph involves dissipation of 7,600,000 ft-lb of energy.**

#### Dynamic Braking

Much has been written and said in recent years about dynamic braking and the beneficial effect it can have on wheel life and the difficulties associated with wheel heating. There is no question that dynamic braking is a godsend. On the other hand, there are limitations to the help which dynamic braking can give, which are not too well understood.

Dynamic braking produces a retarding effect by utilizing the traction motors of the diesel-electric locomotive as generators, the electrical energy developed being dissipated as heat by resistance grids. To the degree heat is dissipated in this way, it relieves the wheels, which is very helpful. The design factors of electrical equipment on diesel locomotives generally limit the dynamic-braking effect to the tractive-power capacity of the unit. For example, a diesel locomotive of 2000 hp capacity can be expected to dissipate in dynamic braking about the same horsepower. This is adequate for holding a normal train to required constant speed on a grade. It is not adequate, however, in stopping trains because here the rate of energy dissipation is many times greater than the amount of power the locomotive can develop.

To illustrate, assume that a 6000-hp diesel locomotive is pulling 20 passenger cars. The diesel locomotive can dissipate 6000 hp of energy dynamically. If the locomotive has 36 wheels and the 20 cars have 160 wheels, the 6000 hp would be distributed over a total of 196 wheels. Thus the dynamic-braking effect available would approximate 31 hp per wheel. As noted previously, the energy-dissipation requirement of stopping a train is many times greater than that. Dynamic braking, therefore, is unfortunately not a cure-all for the problems involved in stopping trains.

#### Wheel Heating

Thus far, reference has been made to the increased heating of wheels which has become characteristic of much of our railroading. There are several types of wheel damage which can result from excessive heating. In stopping a train, where severe braking is done for a relatively short period of time, a high-temperature gradient is developed in the tread and rim of the wheel. At the end of a quick stop, the tread of the wheel will be visibly red while the metal a quarter of an inch or so beneath the tread is still cool. This results in violent quenching by conduction of the metal in the tread with corresponding metallurgical changes in the surface layer of metal. Some of these result in changes in the volume of the steel. Such volume changes, it is believed, are associated with the development of thermal cracks. Furthermore, the expansion of the steel heated to 1400 F or more is considerable. Because this heated metal is firmly anchored to the relatively cool metal below the tread, the heated metal is not able to expand as it would if unrestrained. As a consequence, it upsets. Upon cooling, the upset metal attempts to contract, but still being restrained by the metal which has not been heated and upset, it cannot contract and therefore it becomes stretched. This stretching is related to the development of thermal cracks.

The cumulative effect of alternate heating and cooling of the rims of wheels because of brake-shoe action is toward the development of circumferential tension in the rims. This tendency is greater when the braking conditions are severe and prolonged, but it is inherent to all braking which involves heating the tread of the wheel.

From laboratory investigations it is known that when the rims of wheels which have seen long and severe service are cut across the tread, such as with a hacksaw, they may suddenly crack open radially, sometimes with considerable violence, and the edges of the cut may open up an inch or more, indicating a high degree of tension in the rim of the wheel before the cut was made. A thermal crack in the tread of such a wheel can result in a similar violent type of wheel crack, which may extend radially into the hub and permit the wheel to become loose on the axle, or it may extend circumferentially around the plate and cause the entire outside portion of the wheel to become detached from the hub. A thermal crack thus is looked upon as a serious occurrence.

Railroads are rigorous in their inspection of wheels to determine the presence of thermal cracks and in the prompt removal of wheels where that condition is found. It should be noted that for the thermal crack to result in the catastrophic type of wheel failure described, the appropriate stress condition must first have been developed by service. Heat-treated wheels of the classes generally used for high-speed service are intentionally produced with high residual compressive stress in the rims. As long as that stress condition persists, thermal cracks do not tend to grow suddenly.

The alternate heating and cooling of the rims, however, tend to decrease and ultimately to reverse the original residual compressive-stress pattern, and to develop a pattern of residual tension in the rim with the consequent possibility of a thermal crack growing by sudden rupture. For that reason, some railroads operating unusually severe services remove wheels before they are worn out. This is a safety precaution taken as a means of avoiding the possibility of sudden failure triggered by a thermal crack.

Another heat effect which has not yet been evaluated fully is the development of high radial tensile stresses in plates of wheels as a result of heating of the rims by brake-shoe action. Experimental work conducted in our research and by others has indicated that while the rim of a wheel is heated by severe braking, certain portions of the plate may be stressed to a much higher level than results from the applied external loads. When a stress this great has superimposed on it fluctuating mechanical stresses, such as result from radial load, flange thrust, or the transmission of torque, the fatigue type of failure is a possibility even though the mechanical forces applied are moderate. There have been such failures in service and they were the reason for the initiation of the investigation of stresses due to heating.

### What Can Be Done About It?

Now, what can be done by railroads, designers of equipment, or manufacturers of wheels about these problems? It does not seem likely that the railroads are going back to the operating practices of prestreamliner days. There are economic necessities which have brought about the high-speed passenger train and the diesel locomotive. Similarly, in the field of car design, there does not seem to be any tendency to return to the six-wheel designs of passenger-car trucks. The builders of diesel locomotives, not only for competitive reasons with respect to each other, but because of the constant pressure of the railroads for better motive power, are forced to design their equipment to utilize the last available increment of adhesion between the wheel and the rail, as well as the full capacity of the wheel to carry load and stand heating. No relaxation is foreseen of the present severe operating conditions. Under these conditions, however, it is obviously necessary for the railroads to exert every possible effort to see that the mechanical equipment is kept in a high degree of maintenance.

This has not always been done in the past. According to a file on one passenger operation in which a great deal of difficulty was experienced because of thermal cracking of wheels, many hundreds of pairs of wheels per year had to be taken out of service on that account. The service was known to be severe because of high speeds and yet, for several years, the wheels used on a considerable part of the equipment were of a type known to have the poorest performance in regard to thermal cracking of the three classes of heat-treated wheels covered by the specifications of the AAR. Furthermore, the braking equipment was poorly maintained so that the wheels on some cars were called upon to do much more than their pro rata share of the braking. According to some of the operating reports, during a one-week check on this train, made by the air-brake engineer of the operator, it was found that the brakes were not in proper operating condition on all cars at any time. This threw undue braking loads on some wheels to take up the work which was not being done by the defective equipment.

Months later a renewed survey of the same equipment disclosed situations like this: Out of 11 cars, "8 cars, okay; 3 cars, speed-governor control inoperative." When speed-governor control does not function, those cars on which it is not working do less than two thirds of the amount of braking that they should. On another check, "4 cars working, 7 not working." You can imagine what was happening to the wheels on the four cars which were doing much of the stopping for the other seven. On another check, "2 cars okay; 9 cars, speed-governor control inoperative." However, it is gratifying to report that this particular horrible example is a thing of the past; the mechanical department of the railroad cleaned up the situation and the wheel record today is excellent.

### Brake-Shoe Positioning

Another item which should get much better attention than it does is the proper positioning of brake shoes with respect to wheel treads. Particularly on older equipment where the brake rigging has become worn, many brake shoes, instead of being located centrally on the wheel treads, are overhanging. When a brake shoe extends over the edge of the tread, the part of the shoe remaining in contact with the tread does all the work, which is then concentrated in a narrow band instead of being distributed as the equipment designer intended. An overhanging brake shoe with a moderate brake application has as severe an effect on the wheel as a properly located brake shoe would have with a much heavier brake application.

Now, what can the wheel manufacturers do to help this situation? The industry has done much already. It produces wheels in a number of different compositions in order to give the railroad user a choice of wheel chemistries which best fit his operating conditions and provides a choice of methods of heat-treatment, all covered by specifications of the Association of American Railroads.

The results of destruction tests made on 389 wheels have been reported in Bulletin No. 387 of the University of Illinois. This research project was sponsored by the wheel manufacturers as a contribution toward a better understanding of the factors involved. Work has been continued since that bulletin was issued and has covered such diverse research projects as three-dimensional photoelastic stress analysis, studies of the mechanical properties of wheel steel at high temperatures, the development of a laboratory test to evaluate the wear resistance of different kinds of steel, and a method of measuring the strains occurring in a wheel while rotating at high speed when subjected to brake-shoe heating. Not all of our work has resulted in usable information but that is a hazard inherent to research.

Another question that is asked many times is, "Why does the industry not produce wheels of alloy steel?" That is a natural question, especially in view of the wide use of alloy steels for many high-duty applications. The wheel industry has experimented through the years with a great many analyses of alloy steels (the author has a record of 24 different analyses that have been tried) and is actively working with some of them today.

(*Continued on page 263*)

# New Trends in Machine-Tool Design—Foreign and Domestic

**By Frederick S. Blackall, jr.**

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**Past-President, ASME**

**European machine-tool builders have made enormous strides during the past few years, and in open competition with us already have captured many markets which we formerly dominated. Their sales volume is fully three times any prewar peak. They are making many excellent machines and selling them at a fraction of our prices.**

THE UNITED STATES machine-tool builder faces a two-pronged challenge, both at home and abroad, which he must meet if he is to serve effectively the needs of all segments of industry. In brief, I believe we are approaching a fork in the road, so to speak, where machine-tool designers must give consideration to two radically different classes of machine tools. One branch will lead to a further and intensive development of the present trend toward automatic operation, maximum utilization of horsepower, the ultimate in feeds and speeds, and all of the other features which contribute to the highest possible productivity in mass-production operations. This seems to be the present objective of all machine tools, with the exception of those which are designed primarily for toolroom work. Important though it be for us to pursue this objective vigorously, if we are to hold our own in world competition against producers whose labor rates are a quarter to a third of ours, this objective falls far short of meeting the needs of a very substantial portion of industry.

The influence of the automotive industry on machine-tool design has been great and constructive, but in catering to this important customer, many machine-tool builders have rather gone off the deep end in emphasizing massiveness, a multiplicity of controls, and a degree of automaticity which is practicable only in the mass-production industries. The automobile builder has demanded these changes, and with every right, for his particular purposes. The error has been in the assumption that what is necessary to automotive production probably will be suitable for everybody else. This is far from the case. I believe that a tremendous field is open to the machine-tool builder who will simplify the design of some of the basic machine tools for general-purpose use.

Never forget that there are a great many operations, even within the mass-production industries, which can be performed just as rapidly on a general-purpose machine tool as they can on one of the more complex models. In such cases, many of the more expensive features simply are not used, but they have to be paid for, nevertheless. Many of the new-era machine tools have more handles and push buttons on them than a calculating machine. Some of this complexity is never needed by the average user, and much of it is needed only in special cases by any user. There is, of course, a place for the machine tool which is the ultimate in ruggedness, high speed, variety of special features, and automatic controls, but there is also a place, and I submit that it is an equally important one, for the general-purpose machine tool, designed for average conditions.

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Though it may be heresy for me to say so, I believe that in many cases we have gone so far in the direction of weight and heft, automaticity, push-button controls, and a host of other costly features, that many machine tools are getting to be just too expensive. It grows increasingly difficult for the average concern to keep its plant up to date with the proceeds of its depreciation allowances, even if supplemented by a substantial appropriation from annual earnings. There is a crying need for an attack on this problem, and I believe that one good way to attack it would be to make available an effective range of machine tools of adequate yet more simple design, for the performance of much of the ordinary production of industry—especially small-lot production, which, in the aggregate, plays a tremendously vital part in our economy.

### Need for General-Purpose Machines

Now you may counter that there are already plenty of general-purpose machines on the market. There are indeed some, but most of them are what you might call poor relations—secondary lines—and not at all the type of general-purpose machine which I have in mind. Consider lathes, for example. The general-purpose engine or turret lathe should be built to the same degree of precision as the most advanced high-production unit. It should be capable of performing high-speed turning operations with carbide tools. It should possess a considerable degree of flexibility in the choice of feeds and speeds. Ability to produce a fine finish should be emphasized in its construction, but such machines need not be unduly heavy or massive; they would not be expected to take the heavy cuts required in mass-production work.

Similar characteristics should be embodied in the general-purpose milling machine—a reasonable selection of table feeds from the conventional to the highest, provision for modern milling techniques, including climb milling, provision for flywheel cutters, and in some models, perhaps modest application of automatic features, such as quick return of the table at the end of the

cut. The utmost attention should be given to skillful design of bases, head and tailstocks, tables, columns, and other heavy components, to provide minimum weight consistent with requisite rigidity. The latter should be accomplished through sound design rather than sheer dead weight. The use of weldments, high-physical-property irons, aluminum, magnesium, and plastics should be given increased consideration. I stress in this connection, however, that ability of the general-purpose machine to turn out precise work and maintain its accuracy is of primary importance. This is a challenge to the engineer, but a great deal can be accomplished by the astute designer in the direction of improved rigidity and ruggedness without going overboard on massive construction.

**In the face of growing competition from abroad, American industry must utilize to the utmost its advantages in mass-production operations. To this end machine tools representing the ultimate in ruggedness, high speed, variety of special features, and automatic controls must be developed. And of equal importance, general-purpose machines to meet average conditions in every industry are vitally needed.**

### Pricing Machines for the Market

In producing such machines, the most modern and efficient production techniques should be followed to permit them to be priced as moderately as possible. Standardization of parts and the maximum possible interchange of parts within a given line of machines should be sought to minimize costs. Components should be well tooled up and efficiently gaged, to the end that machines will virtually fall together in assembly, with a minimum of cutting and fitting. Here is where a lot of time can be saved in manufacturing. In brief, every possible step should be taken to produce such machines at really low cost.

I believe that the machine-tool builder who will approach the problem from this angle will be amazed at the volume of business which he can develop. Indeed, volume should be much more readily attainable on equipment of this nature than on mass-production equipment where the special requirements of each large buyer have to be given their sway. General Motors, Ford, and Chrysler, all have their own standards and special requirements which you and I have to respect, but if my company, for example, wants a machine-tool builder to depart from the norm on two or three lathes for chasing thread gages, we are pretty apt to get the cold shoulder, especially if business is good. The intelligent development of efficient and accurate general-purpose machines of advanced design is not only one of industry's more urgent needs; it also holds a great sales potential for the machine-tool builder.

If you doubt that there is a market for the soundly designed general-purpose machine of moderate price, take a look at what one well-known New England concern has done during the past decade in the field of light but effective small milling machines. With foresight and intelligence, they bucked the trend toward bigger, more complex, more expensive machine tools and brought out a small machine which sells at a fraction of its nearest equivalent in the traditional standard milling-machine lines. The trade was suspicious at first and thought this was just another second-rate milling machine, but you will see them today in top-notch plants all over the country. For some reason which is hard to fathom, they have no real competitors. This is the kind of a job which I think ought to be done throughout the whole range of basic machine tools in the development of a modern, effective, accurate, versatile line of general-purpose machine tools which can be sold at a moderate price. It is one of the crying needs of industry today.

I have mentioned this first because it is a need which doesn't seem to be recognized by the machine-tool builder on any broad scale. The technical journals are not apt to take up the cudgels for this sort of thing either, because such machines are not spectacular. It is much more newsworthy to write up a machine which makes chips so fast that they have to be carried away by a continuous conveyer. One forgets, however, that small and medium-sized businesses are still, in the aggregate, the largest consumers of machine tools and the largest contributors to our national income. In brief, we are neglecting our biggest customer.

At the other end of the scale, our mass-productive industries must be given machines which are the ultimate in productivity per unit of labor, for American manufacturers, during the next decade, will face some of the toughest problems which they have ever experienced. With prices already sky-high and labor rates still rising, failure to reduce the cost of production continuously could become a national calamity, adversely affecting our standard of living and inviting depression, or worse, a spate of make-work panaceas for depression. Furthermore, we face a new kind of competition from overseas.

### Europe Planning Invasion of U. S. Market

European manufacturers, hungry for dollars, are planning a wholesale invasion of our markets. Newly equipped with the best in American, German, British, Swiss, and Swedish machine tools (purchased to a considerable extent with your tax dollars), enjoying labor rates which are a small fraction of our own, they will be aided and abetted by the revolutionary changes which we have made in our tariff policy.

The United States has done more in the direction of reducing customs duties during the past ten or fifteen years than any other major power. While Europe has been berating us for high tariffs and demanding unrestricted nondutiable access to our markets, she has been raising her tariffs, and, furthermore, surrounding her markets with all manner of import restrictions. During the same period, we have reduced our tariffs through reciprocal agreements and otherwise by over 60 per cent. The average duty on all of our imports for the fiscal year 1951 was only 4.9 per cent as compared with 13.1 per cent for the fifteen leading countries of Free Europe.

Averages, of course, are deceptive, and I do not contend that there are not still some phases of our tariff laws which do not need adjustment. Among these are the petty annoyances implicit in our ambiguous import

regulations, which often make it difficult to determine conclusively just what the duty is on certain imports. Nevertheless, it is high time we face the little-realized fact that the whole character of our foreign-trade policy has changed enormously during the past two decades and that, relatively, we are now a low-tariff, not a high-tariff country. Hence American manufacturers must get their houses in order and provide themselves with equipment which will minimize the inordinate disadvantage from which we suffer relative to Europe in our cost of labor, for we are going to have to meet competition from overseas of a sort which we have never faced before.

### Must Keep Lead in Production Tools

Since the volume competition will be borne by the mass-production industries, American machine-tool builders must take care to maintain the lead which they now enjoy in the special field of tools for production. This is vital, and it must not be assumed that my parallel interest in the development of general-purpose machine tools implies any lack of appreciation of the tremendous importance of this market. What, then, are the trends to which the designer should be alert in planning the mass-production tools of tomorrow?

Of course the big word at the moment is "automation"—a word which I detest, and even worse, machines which are "automated;" but unquestionably this is an important trend in production tools.

The high cost of labor will stimulate the effort to reduce the human element at every possible point, to make the machine pace the operator, rather than vice versa, and to minimize operator fatigue. These objectives will be served by continued emphasis on automatic features, design which will simplify the maintenance problem of the large plant, and sturdy construction which will permit the use of carbide tools at their maximum capacity at all times.

Every possible step should be taken to assure machine operation at optimum speeds and feeds. Incidentally, machine designers would do well to give increasing attention to higher speeds and feeds not only in turning and boring operations, but on millers, planers, shapers, and the like. In many cases we have not yet begun to approach the full potential of cutting tools made from modern superhard cutting materials.

### Reducing Machine Down-Time

However, optimum speeds and feeds are not the sole answer to cost reduction. A careful operations analysis usually will indicate that actual machining time is a surprisingly low proportion of the total production time. Setup, loading and unloading, gaging, and checking take a heavy toll in costs. Thus there will be a growing emphasis on cutting the time involved in performing nonproductive elements of the work and in reducing machine down-time. Automatic loading will come in for its share of attention, as well as ease of chip removal. The latter need not necessarily imply conveyer mechanisms, but in some cases may involve departure from traditional construction.

Such a trend is evident in the Fischer lathe and machines of similar design, in which the ways are disposed at an angle approaching the vertical plane, permitting the chips literally to fall out of the machine instead of into the bed. The engineer of tomorrow will not be inhibited by tenets of traditional design. Automatic gaging features will come into increased use, both on the machine tool and in the form of separate gaging machines. The air gage, the electric gage, and electronic devices are particularly suitable for working into machine-tool construction and in many cases will effect substantial cost savings.

Similar considerations will affect the design, for all classes of machine tools, of special tools and other aids to manufacture, set-up, and preselective positioning devices, and so on. Incidentally, the latter, both as built-in features and as accessories, are converting the horizontal boring machine into a highly versatile unit for job-lot production. Angle irons and similar fixtures will be designed in such manner that the work can be mounted on or within them, and the whole assembly can be moved from one machine to another without disturbing the location of the work within the fixture. Other means of reducing down-time are chip removal without stopping the machine, with chip breakers to facilitate this, duplicate tables, one for loading, one for machining, and so on.

### Packaged Units

Ease of maintenance should favor the trend toward construction of many production-type machines from so-called "packaged units." These enormously simplify the repair problem. A rough spindle, a bearing gone bad, a built-in motor burned out occasions no serious interruption on the production line if a duplicate packaged unit is at hand as a replacement. Packaged units also permit the machine-tool builder to meet the growing demand for special-purpose machines without completely sacrificing the economies of standardized production.

Now may I turn to some of the details which will inevitably engage the attention of machine-tool designers to an increasing extent in the future.

I predict that hardened and ground ways of steel, or with hardened steel inserts, will gradually displace the traditional hand-scraped cast-iron construction. Ways constructed in this manner from alloy steels will outlive cast iron many times, and when wear finally does necessitate overhaul, the repair job is enormously simplified. Such construction, properly designed and tooled, may even be less expensive in the long run than the conventional design. When employed in combination with ball or roller-bearing supports, or nonmetallic plastic facers, lubrication is simplified and ease of operation is enhanced manyfold.

Greater attention will be paid to coolants and lubrication both of the cutting tool and of the machine itself. In the high jet-coolant process, the tool is lubricated by means of a high-pressure spray, but the chip is not quenched. Increases in machining time as high as 30 per cent are claimed for the method.

I foresee superspeed fine-surface-finish milling operations coming more and more to the fore. These, and high-speed boring and turning, with diamond tools or carbides, already are producing amazingly smooth and accurate surfaces. The quality of finish which some milling-machine builders have attained during the past few years is eye-opening. Of course this type of milling takes heavy, rugged, overpowered machines of the most advanced type, but where the production run justi-

fies the investment, they are enormous timesavers. Improved methods of evaluating surface finish will intensify the trend toward higher precision and finer finishes. In both of these matters, lathes, millers, and boring machines will approach the present potential of grinding machines, in some cases entirely eliminating the need for supplemental finish-grinding operations.

Two somewhat dissimilar trends are evident in the design of spindles. As the latter become larger and heavier, the use of ball and roller bearings for support and thrust will become more commonplace. However, certain European manufacturers of grinding machines are reverting to the plain bearing with mist lubrication for high-precision operations. It is an interesting development, which has been carried to a high degree of perfection on some of the British machine tools. While I advocate the ball or roller bearing for most spindle applications, there may be a field for the plain-bearing grinding spindle in certain superprecision operations. Grinders of this type are produced by Newall in England and Jung in Germany, and possibly some others. When new, these spindles operate with amazing quiet and lack of vibration and produce a beautiful finish, but their life is limited and the least bit of trouble means a factory rebuilding job.

### Electronic and Hydraulic Mechanisms

The development and perfection of electronic and hydraulic mechanisms for machine-tool drive and control has rendered practical the provision of infinite speed and feed changes within the range of the machine. This is a highly desirable feature, but neither hydraulic mechanisms nor electronic controls are yet sufficiently trouble-free. In both instances, the dissipation of heat to avoid distortion of beds and tables still remains something of a challenge to the designer of high-precision machines. Perhaps the development of the transistor as the successor to the vacuum tube will solve the problem in so far as electronics is concerned.

No such immediate solution appears to be in sight for hydraulic mechanisms, which frequently generate too much heat, impairing or rendering unreliable the accuracy of the machine. Furthermore, many hydraulic mechanisms leave much to be desired because of their tendency to develop leakage. Inadequately designed or low-quality tubing and fittings in machine-tool hydraulic systems account for a substantial maintenance expense in many a plant, not to mention a lot of costly down-time. Hydraulics is here to stay. It is high time that their application to machine tools was perfected. Perhaps we could learn something from the designer of aircraft hydraulic mechanisms in this particular.

More will be heard of the results of recent research in the rapid cutting of ferrous and nonferrous metals, the disposition of coolants and cutting lubricants, and certain revolutionary developments now far advanced, some here and some abroad, in hitherto unknown methods of removing metal. Among these are a superspeed grinding process developed by Fouquet in France; another is Method X, sometimes called the spark or electrolytic method of metal removal, which employs an electric arc rather than a cutting tool for the purpose, or sometimes electrolytic means in combination with a metal-bonded grinding wheel; and finally the flame process, in which the work surface is brought to a red heat ahead of the cutting tool. Another interesting development which holds future promise is that of turning by milling, in which the work is revolved and the lathe tool is replaced by a rotary multitoothed cutter.

And now may I turn to the European influence on machine tools and some of the developments which are taking place over there. For many years the American machine-tool builder has maintained a position of recognized world leadership, but it is a leadership which is faced with serious challenge from abroad. We must not be complacent or too ready to assume that foreign engineers don't know how to design good tools. Nothing could be further from the truth.

### European Influence on Developments

Some of the progress which we ourselves have made in late years had its inception in Europe. Examples of this are high-speed planing, thread grinding, optical controls, a fair share of the trend toward automaticity, precision profiling by the optical method, and many latter-day developments in gaging. Just as the microscope, now the basis of much of our precision measurement, was a Dutch invention, and the micrometer was developed by Palmer in France, so the influence of the great German firm of Carl Zeiss, now unhappily broken up by the Russians, has been outstanding in the field of fine measurements. Their designs were the real genesis of optics as applied to precision gaging and machine-tool controls. Not until World War II when they were copied almost in the Chinese manner, so to speak, by England, did any other nation approach the Germans in this field. In it, the Germans and the British still have a big lead over us, and most of our domestic developments are largely copies of European prototypes.

Air gages, which now have been brought to a state of evolution in this country not yet equaled in Europe, were, nevertheless, originally devised by Solex in France shortly after World War I. The initial application of air gages to machine tools themselves to control size and stop the machine on completion of the operation was first tried out in Europe, and I suspect is used there today more widely than it is in this country. It is a trend which will increase.

I shall probably encounter skepticism, when I say that Europe has consistently led the United States in planer development. The use of tungsten-carbide planer tools, operating at speeds up to 250 to 300 feet per minute, was commonplace in England before World War II, at a time when American planer manufacturers still considered 100 feet as a high speed for their product. At long last we caught up with them and perhaps even improved on European practice; but planer manufacturers would do well to take seriously some further developments in the art which are just making their appearance on the other side of the water.

The French firm GSP is now producing a machine which planes in both directions, thus eliminating the lost time in the return stroke. I predict that this development will take hold, just as I predicted in *Iron Age* in February, 1936—seventeen years ago—that planer speeds of 250 feet per minute would be commonplace one day. The trouble with Americans in such matters is that they tend to scoff at European developments until they become so obvious that they no longer can be ignored. I should class the two-way planer in this category.

It is interesting that the Germans seem more intrigued

with full-automatic operation than we do. In their country, one hears much about the push-button factory of the future, but in mass-production operations, our need for it is really greater than theirs, because of our much higher labor costs.

In their preoccupation with the push-button factory, the Germans have given a great deal of attention to what they call programming machines. Based, for the most part, on electronics, these machines are activated by a series of push buttons to perform a multiplicity of preselected operations automatically. Many competent American engineers regard them as dangerously complex and question whether the time they save will be offset by their capital and operating costs, their potential for trouble, and their high maintenance expense. For my part, I think the American mass-production approach to multiple operations has been much sounder, breaking them down into steps, so that if one machine or component breaks down, it won't interfere with the operation of all of the others. The American approach to the multiple-operation problem, in brief, has been to build it up from individual or easily separable units. Nevertheless, the Germans' fascination with the push-button factory is a trend to be watched.

#### Cornerstone of Our Industrial Economy

So much for my seance with the crystal ball. I am sure that I have not called all of the shots, and I may have guessed wrong on some of them. But if I have stimulated your thinking, my time and effort will have been well spent, for I am thoroughly convinced that America, in general, and the machine-tool builder in particular, face a real challenge in the next decade or two. Machine tools are not only "America's muscles;" they are the very cornerstone of our great industrial economy. Their efficiency and performance will determine in large measure whether we can maintain or continue to raise our standard of living in the years to come. And if the cold war should wax hot, American superiority in machine tools could be the tenuous margin between victory and defeat.

Thus in a very considerable sense, America's future rests in the hands of the machine-tool engineer. I am confident that he will not let us down.

## The Wheel Manufacturer Looks at Railroading

(*Continued from page 258*)

An economic factor enters into this consideration which must not be overlooked. A wheel is an expendable item. It has a limited life, and any alloy composition to be successful must have an economic advantage. If we are to spend $100 for alloy steel to gain $10 worth of advantage, the railroads are apt to take a dim view of that kind of improvement. Thus far, none of the alloy analyses developed experimentally has received any substantial acceptance by wheel users.

#### Conclusion

This paper has pointed out what seem to be some of the predominant elements in the present situation and has dwelt considerably on troubles because it seemed the best method of studying means by which troubles could be avoided. Actually, wheel failures are extremely rare in terms of miles traveled. In 1951, according to the most recent ICC accident bulletin, there were 496 train accidents attributable to failures of all types of wheels. The total of locomotive and car miles for the year was over 36.1 billion. As each locomotive or car has a minimum of 8 wheels, the total wheel-miles exceeded 288 billion. This means that one accident was caused by a wheel failure for each 583 million wheel-miles—over six times the distance from our earth to the sun—not a perfect record but surely not a bad one. Since any wheel failure is apt to result in an accident, we can look forward to continued work by the railroads, the designers of equipment, and the wheel manufacturers toward an even better record for the future.

## Tonnage Oxygen Unit

A TONNAGE oxygen unit, the only one of its kind in Canada, for production of the vast quantities of oxygen required for the direct flash smelting of copper concentrates has been placed in operation in Copper Cliff, Ont., by The International Nickel Company of Canada, Ltd. Inco's new oxygen flash-smelting process eliminates the fuel normally required for smelting and makes economical the present large-scale output by Canadian Industries Limited of liquid sulphur dioxide from furnace exhaust gases.

The company's operations call for a volume of more than 7,500,000 cu ft of oxygen every day—enough to fill 32,000 standard cylinders. The company's oxygen plant produces 300 tons of 95 per cent pure oxygen every 24 hours.

The oxygen plant, designed and built for Inco by Canadian Liquid Air Company, Ltd., and known as an "Oxyton," separates the oxygen from atmospheric air by the liquefaction process, using the same basic principles involved in smaller commercial oxygen plants. The air is liquefied under pressure in a series of compressors, regenerator-heat exchangers, distillation columns, and other equipment. Finally, the oxygen is separated from the other constituents of the atmosphere—nitrogen, argon, neon, and krypton. In gaseous form, the oxygen is then carried in a 16-in-diam elevated pipe line from the Oxyton to the smelter, a distance of 6000 ft.

Because temperatures as low as several hundred degrees below zero are involved in the liquefaction process, special consideration had to be given to the types of metals and other materials employed in certain parts of the oxygen generating unit. For example, the important regenerator-heat exchanger system consists of two nitrogen regenerators, each 8 ft in diam and 17 ft long, and two oxygen regenerators, each 4 ft in diam and $14^{3}/_{4}$ ft long.

While one pair of regenerators chills the incoming air, the other pair is being chilled by the separator gases. Working temperatures range from 80 F to minus 280 F.

Since most ferrous metals suffer a marked increase in brittleness to subzero temperatures, the regenerators were made from special $8^{1}/_{2}$ per cent nickel steel, developed by Inco for low-temperature use. The regenerators are of welded fabrication, employing type 310 stainless-steel electrodes.

# *Briefing the Record*

**Abstracts and Comments Based on Current Periodicals and Events**

**J. J. Jaklitsch, Jr., *Associate Editor***

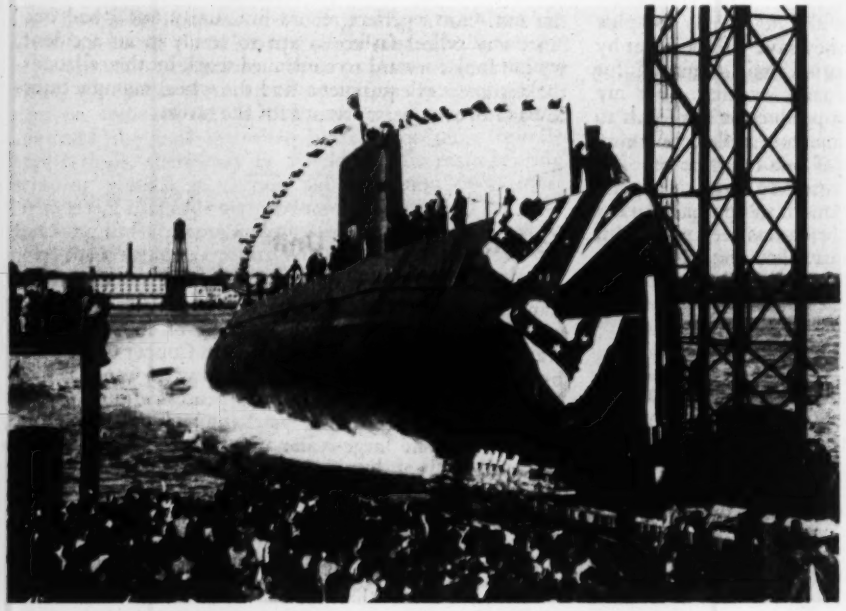


Fig. 1 World's first nuclear-powered vessel enters water at Electric Boat Division of General Dynamics Corporation as the U.S.S. *Nautilus* is launched

## Atomic Submarine Launched

THE first atomic engine in the nation's history turned the propeller shaft of a "dry-land submarine," built in the middle of an Idaho desert, on May 31, 1953.

This history-making engine, built by Westinghouse Electric Corporation under contract with the Atomic Energy Commission and in co-operation with the AEC's Argonne National Laboratory, was the land-based prototype or experimental model (Mark I) of the nuclear power plant (Mark II) that will propel the first atomic submarine, U.S.S. *Nautilus*. (See frontispiece, page 224, of this issue.)

The *Nautilus* was launched on January 21, 1954, by the Electric Boat Division of General Dynamics Corporation at Groton, Conn.

The desert-bound atomic engine is a full-sized power plant installed inside two sections of a submarine hull. The reactor compartment is surrounded by its own private ocean—a large "sea tank" full of water.

The second atomic engine, Mark II, also built by Westinghouse, will make the *Nautilus* an around-the-world submarine, capable of cruising submerged at speeds above 20 knots.

With most components of the engine now installed inside the *Nautilus* hull, Mark II is the most powerful submarine engine ever built. Fleet-type submarines in World War II had engines of about 6000 hp.

The engine also indicates the feasibility of a civilian atomic power plant to produce electricity for home and factory. The *Nautilus* power plant could furnish enough electricity to meet the needs of a small city.

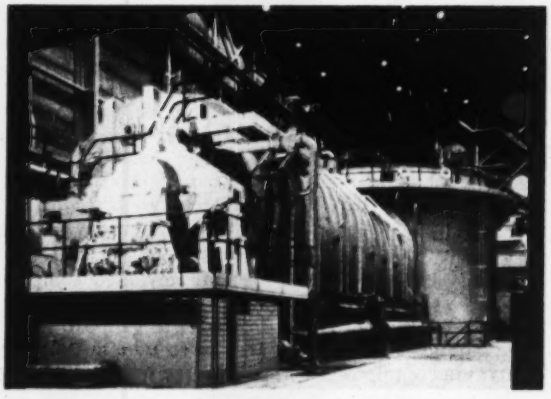


Fig. 2 Inside the hull of this "indoor submarine" located in the middle of an Idaho desert is the first atomic engine ever to produce substantial quantities of power. This nuclear power plant, Mark I, was built for long-range testing and operation, and is a prototype of the actual engine, Mark II, which will drive the atomic submarine, U.S.S. *Nautilus*. This view of the first atomic engine, Mark I, looking through the largest door of the main assembly building, shows the aft end of the hull and the "sea tank" which surrounds the reactor compartment.

Because a nuclear reactor of this type does not require oxygen for its operation—as does a combustion engine—the *Nautilus* will be able to operate at top efficiency for long periods of time while submerged. It thus will be the first true submarine.

An ordinary submarine must depend upon batteries when completely submerged. As a result, it travels at much slower speeds than the *Nautilus*, and for much shorter distances—usually less than 100 miles. It then must surface to recharge batteries. In sharp contrast, the *Nautilus* will be capable of crossing the Atlantic Ocean submerged and at full speed. Because of the prodigious potential energy in a lump of uranium the size of a golf ball (two pounds)—it is equal to 460,000 gal of fuel oil or 3000 tons of coal—the *Nautilus* will be able to cruise around the world without refueling.

## Experimental Atomic Battery

An experimental atomic battery, which for the first time converts atomic energy directly into small but useful quantities of electricity, has been unveiled by Radio Corporation of America, New York, N.Y.

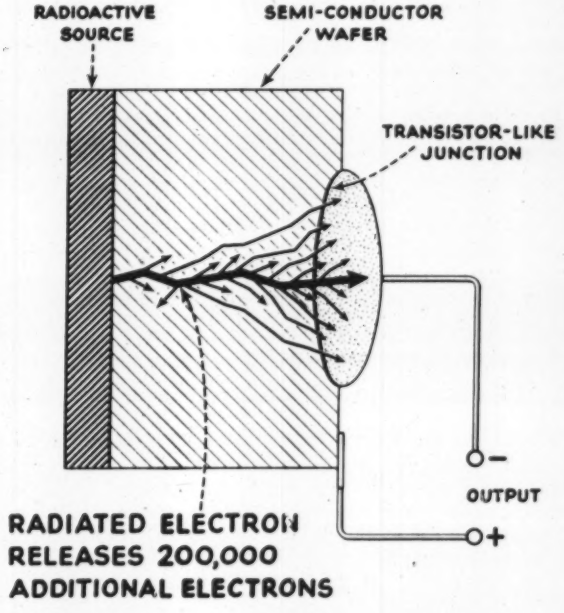



**Fig. 3 Simplified cross-section view of experimental RCA Atomic Battery. Radioactive source, which is strontium-90 in present version, radiates billions of electrons (beta particles) per second for many years. Each electron captured by the semiconductor wafer releases on the average 200,000 more electrons which build up voltage as they flow across the junction. RCA's combination of radioactivity and semiconductor techniques has made possible in the laboratory first direct conversion of atomic energy to useable electricity of sufficient energy to operate a transistor.**

### How Atomic Battery Works

As described by Dr. E. W. Engstrom, executive vice-president in charge, RCA Laboratories Division, the new type of atomic battery consists of a radioactive source to which is coupled a wafer of semiconducting crystal (germanium or silicon). An impurity material has been alloyed into the crystal to form a junction. The junction is similar electrically to those used in a junction transistor, but is considerably larger, with an area of $^1/_{20}$th of a square inch.

Strontium-90, one of the most abundant of the materials resulting from the fission of uranium in a reactor, is a highly active source of beta particles—high-speed electrons—and is one of the long-lived beta-emitting substances. Its half-life is roughly 20 years, i.e., every 20 years half of its radioactivity is dissipated.

**Fig. 4 RCA developmental Atomic Battery, which directly converts radioactivity to small but usable quantities of electricity, being tested in a special laboratory setup by Paul Rappaport, RCA physicist, at David Sarnoff Research Center of RCA, Princeton, N. J. Radioactive source is thin layer of strontium-90 in base of small cylinder (*top center*) at end of rod. When cylinder is moved into round hole (*top left*) battery action starts, producing current to operate tone-producing device held by Mr. Rappaport.**

In the battery, $^1/_{300}$th of a cubic centimeter (a quantity that would fill a cube $^1/_{16}$ in. on a side) of radioactive strontium is spread in a thin layer against the junction wafer. The layer of strontium bombards the semiconducting crystal wafer with several billion electrons per second. As the electrons penetrate the wafer they release many more electrons, an average of 200,000 for each bombarding electron.

Previous radioactive generators simply captured the high-speed electrons as they came from the radioactive source with the result that they provided approximately one electron for each bombarding electron. In the RCA experimental atomic battery, each high-speed electron releases in the crystal, on the average, 200,000 low-speed electrons. These released electrons flow across the

wafer's junction producing a voltage which can be applied to an electronic circuit and cause a current to flow.

The electron action within the crystal wafer is known as the electron-voltaic effect, a phenomenon of solid-state physics which heretofore has not been put to any practical use.

When connected to the transistor oscillator circuit, the battery's $^1/_5$-volt potential provides a current of 5 microamp, an output of approximately one millionth of a watt.

The best efficiency of energy conversion so far obtained exceeds one per cent, i.e., the ratio of useful electric power developed by the battery is at least $^1/_{100}$th the energy of the beta particles as they leave the radioactive source. The greater part of the original energy is lost as heat in the crystal wafer. As present techniques are refined, an efficiency of 10 per cent appears to be a reasonable goal for such devices.

#### Possible Applications

According to David Sarnoff, chairman of the board of RCA, the atomic battery is likely to be applied first to miniature devices such as portable and pocket-size radio receivers, hearing-aids, signal control, and similar devices that require reliable power sources with great length of service. It may also be possible to use them for operating portable short-range transmitters for radio telegraph and telephone communication and radio beacons for navigation by air or by sea, he said.

Such atomic batteries will be highly compatible with future equipment using transistors. Both the battery and the transistor have the potential advantages of compactness, ruggedness, and long life, Mr. Sarnoff pointed out.

#### Distant Future Prospects

In addition to the foregoing, Dr. Engstrom pointed out that previous proposals for large-scale electrical power generation from the fission of uranium in a reactor have been based on an indirect method. By that method the tremendous amount of heat energy created by the fission is used to produce steam, which drives a turbine, which in turn drives a conventional electrical generator. But in contrast, RCA's laboratory method of converting nuclear energy to electrical energy is a direct conversion.

Hitherto, power from the atom has been used in much the same way as coal in the furnace of an electric power plant, said Dr. Engstrom. All the remainder of the plant remained unchanged—boilers, and an engine or turbine driving an electric generator. Only the nature of the fuel was altered when nuclear energy replaced coal or oil.

But, he said, if the promise of the RCA atomic battery is ultimately fulfilled on a large scale, the power plant of that day would have only an atomic generator connected directly to cables carrying to far-flung communities the power needed for the multitudinous purposes of peace. Boilers, engines, and electric generators would then increasingly become elements of the past.

Naturally, much fundamental work and applied research remains to be done and many years will elapse before such a goal is attained. Nevertheless, Dr. Engstrom said, this prospect offers a bright hope for mankind.

## 25 Billion-Volt Accelerator

The U. S. Atomic Energy Commission has approved design and construction at Brookhaven National Laboratory of an ultra-high-energy particle accelerator for nuclear research. The new machine, an alternating gradient synchrotron, will be designed to produce beams of protons of energies ranging up to 25 billion electron volts.

The alternating gradient synchrotron will use a series of alternate strongly converging and diverging magnetic fields to confine a proton beam in a tube of relatively small cross section. This focusing effect allows the production of high-energy beams with smaller electromagnets and related equipment than would otherwise be possible.

The cost of design and construction of the new accelerator is estimated at $20 million. Design work will start at Brookhaven in the near future and it is expected that the machine can be completed in five to six years. Once in operation, it will be available to scientists wishing to collaborate in Brookhaven research programs or to carry out independent programs.

As a means of producing nuclear reactions under controlled conditions on a laboratory scale, particle accelerators have played an important role in the advancement of nuclear science and contributed much of the fundamental scientific information used in the design of nuclear reactors.

The most powerful accelerator now in operation is the Brookhaven Cosmotron, which has accelerated protons to energies of 2.3 billion electron volts. The Bevatron, under construction at the University of California Radiation Laboratory at Berkeley, is expected to accelerate particles into the 5 to 7 billion electron-volt range.

By providing particles with energies as high as 25 billion electron volts, the Brookhaven alternating gradient synchrotron is expected to contribute important new knowledge of the fundamental nature of matter.

## 100-Kw Nuclear Reactor

The allocation of fissionable material as fuel for a nuclear reactor to be built by Pennsylvania State University, has been approved by the U. S. Atomic Energy Commission.

The low-power "swimming-pool" type reactor will be operated for nuclear research and for the training of students. It is the second privately owned reactor for which the AEC has authorized the use of nuclear fuel. The first, built by the Consolidated University of North Carolina, began operation Sept. 5, 1953.

The Pennsylvania State University reactor will be constructed and housed on the university campus for an estimated $250,000 to $300,000. The cost of construction and operation will be borne by the University, without financial assistance from the AEC. The reactor will operate at a power level of 100 kw. It will be cooled and moderated with ordinary water and will use enriched uranium fuel. The fuel elements will be suspended in a pool of water sufficiently deep to serve as a shield against the radiation produced by the reactor.

A similar swimming-pool facility, the Bulk Shielding Test Reactor, has been in operation at Oak Ridge National Laboratory since 1952. Experience with the Bulk Shielding Test Reactor has demonstrated that it is inexpensive, safe to operate, and easy to maintain.

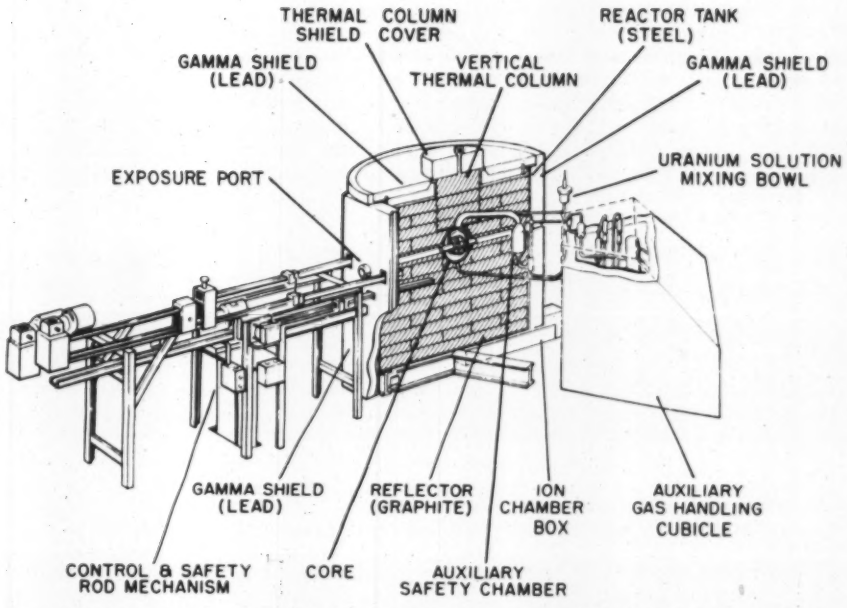



**Fig. 5** Artist's sketch of water-boiler-type nuclear reactor designed to study materials and components in connection with nuclear research for the AEC. Control rods, *left*, regulate the fission process in the one-foot sphere or core, *center*, where four gallons of uranyl sulphate are contained. Unique feature of the reactor is that it emits no exhaust or fumes as is the case with other large reactors of this type.

## Self-Contained Nuclear Reactor

A SELF-CONTAINED "water-boiler-type" atomic-energy reactor for special nuclear research has been designed and built by North American Aviation, Inc., Downey, Calif., for the Atomic Energy Commission.

The new reactor now is in operation by the California Research and Development Company, Livermore, Calif., a contractor of the San Francisco Operations Office, U. S. Atomic Energy Commission. The reactor, which is being used for research, is the second in California. The first reactor was designed and built by North American for atomic research at the company's Downey, Calif., plant where the firm's Atomic Energy Research Department is located.

### 100 Watts of Power Developed

Developing 100 watts of power, the reactor is unique in that it is the largest unit of its type to operate with a closed cycle, or "self-contained," system. The water-boiler-type reactor, one in which the fissionable uranium compound is contained in a water solution, is designed so all radioactive by-products of the fission process are retained in the unit instead of being exhausted and mixed with the open air, as in the case of other large reactors of this type. Radioactive by-products in the North American reactor are processed inside the unit and returned to the reactor core. It is possible for the reactor to run for as long as 10 years without refueling, the company states.

Nuclear research scheduled for the new reactor will include fundamental studies as well as test work with various materials and components being studied for possible application to atomic-energy equipment and processes. At 100 watts of power the unit will produce a concentrated field of neutrons to bombard and irradiate test materials.

If required, the reactor can be converted to operate at 2000 watts of power to produce an even greater neutron "flux" or stream of neutrons sometimes required for more advanced or more critical experiments.

Power ratings for water-boiler research reactors are much lower than those for other types under development by North American for the production of civilian and industrial electric power. The company recently announced the design of an atomic pilot plant to produce 8 million watts of electric power, a preliminary step toward the development of larger nuclear reactors to produce several billion watts of power in the same category of present conventional-fueled electric-generating plants.

### Uranyl Sulphate Fuel

The reactor will be "fueled" with uranyl sulphate, enriched in fissionable Uranium-235, in a water solution. About four gallons of this material is housed in a steel sphere, one foot in diameter. A cylindrical stack of graphite bars, to reflect the neutrons produced by the fission process, surrounds the sphere. This entire assembly is housed by a steel tank five feet in diameter and five feet high. Two control and two safety rods, made of cadmium and boron, run through the tank to the sphere. Because these rods absorb neutrons, their presence near the sphere "shuts off" the fission process. When the rods are withdrawn the Uranium-235 solution begins the atomic fission process producing neutrons and other nuclear radiations. Access holes leading through the tank to the sphere permit the bombardment of test samples by neutrons and other radiations. During ordinary operation, only the two control rods are used to start, stop, and regulate the fission process. The two safety rods are designed to automatically shut off the reaction if required.

Inherent characteristics of the design of a water-boiler reactor make it virtually impossible for the fission process to "run away." If an uncontrolled fission occurs, the heat of the reaction in the water solution will stop the process before damage can be done. The safety rods can be used with the same effect. In addition to the natural safety feature and the safety rods, the reactor is equipped with an auxiliary safety-chamber system as a further safeguard. A completely new development, the safety chamber provides a method of reducing the amount of fissionable material in the sphere to less than

a "critical mass," or to an extent that fission cannot occur. This is accomplished by a "percolating" process. If fission gets beyond a certain rate, gas bubbling through the uranyl sulphate solution carries the material into the auxiliary safety chamber and away from the fission sphere, in the same manner that steam percolates water over coffee in the family coffee pot.

To obtain a stable power level for the reactor, North American's Electromechanical Engineering Department has designed a special servo system to adjust automatically the control rods as required to maintain a given power setting, or rate of fission.

## Low-Cost Digital Computer

DEVELOPMENT of a new low-cost, general-purpose electronic digital computer, ALWAC, for use in science and industry has been announced by Logistics Research, Inc., Redondo Beach, Calif.

According to the computer's developers, ALWAC provides increased reliability and cost savings, never before realized with previous machines. Its internal memory system is claimed to be the most efficient of any low-cost general-purpose computer ever developed. The project is backed by Dr. Axel L. Wenner-Gren, internationally famous Swedish industrialist. ALWAC stands for "Axel L. Wenner-Gren Automatic Computer."

Jobs that computers like ALWAC can do faster and more accurately than humans include small, medium, and large repetitive engineering calculations; complex scientific calculations; preparation of handbook data; correcting of test data to standard conditions and interpreting results; statistical studies; weight control in aircraft design, automatic reading, recording, and reduction of test data.

Technically ALWAC is a serial, binary computer with an internally programmed magnetic drum. The machine consists of an arithmetic unit, memory unit, control unit, and input-output sections.

### Magnetic Drum Memory

ALWAC features a large-capacity rotating magnetic drum memory of 2048-word main-storage capacity which stores the numbers and "commands" (instructions) used by the machine to perform its computations. All of the units of the machine make use of information stored on the surface of this drum. The drum is composed of a cylinder rotating about its longitudinal axis, with a number of reading and writing heads mounted in near-contact with the surface of the cylinder. A given head serves both as a reading and writing device.

Basic commands are put into the machine and answers obtained from it, on electric typewriters and paper-tape perforating and tape-reading equipment. As many as ten electric typewriters can be attached to the machine at various remote locations.

Numbers to be entered in the computer normally are typed on the electric typewriter in decimal form with decimal point and sign. Alphabetic information can also be handled. A visual copy is typed at the same time, which may be compared immediately with the coding sheet for typing errors. The information then is transferred automatically to magnetic drum storage by the tape reader. Information also can be entered manually directly from the typewriter keyboard. Conversion from decimal-to-binary and binary-to-decimal automatically is performed at approximately the maximum rate of the electric typewriter reading and writing speed of ten operations per second.

Automatic graph-following and graph-plotting equipment also can be provided as input and output equipment for this computer. One version of the automatic graph follower will handle a function of two variables. Families of curves on a single sheet may be used, and the follower automatically will switch

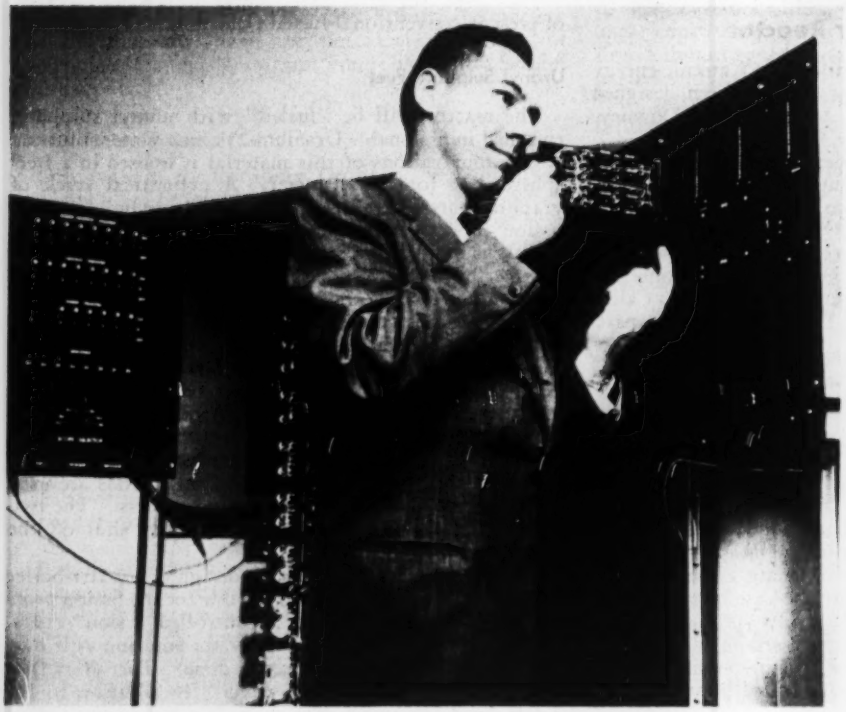


**Fig. 6 ALWAC's electronic components are arranged into standard plug-in units to minimize maintenance. Using this built-in test box all components in the computing circuitry can be given a static and dynamic check in excess of the normal operating requirements in less than an hour. The test panel shows a green light if the unit is perfect, shines red if the unit must be replaced.**

**Fig. 7 ALWAC's brain is this magnetic drum which stores the instructions used by the machine to perform its computations. Glenn E. Hagen holds one of the heads which, when mounted in near contact with the surface of the cylinder, serves as both a reading and writing head.**

from one curve to another in response to commands from the computer and automatically transmit the reading to the computer's memory.

#### Internal Programming

To the direction of internal programming the Arithmetic Unit performs the four arithmetic operations of add, subtract, multiply, and divide. Forty-two variations of these basic operations are included in possible commands. A remote-control panel permits the operator to change manually previous instructions in accordance with the progress of the problem.

The Control Unit controls the activities of the machine. The Control Unit receives command words from the Memory and receives other signals from the Arithmetic Unit. It combines this information and transmits the proper impulses to the Arithmetic, Memory, and Input-Output Units so that they perform the operations specified in the commands. The Unit includes the Command Register, which holds the instructions which control the machine at any given time, and the Control Register to which the instruction is transferred when it is actually controlling the machine. A "Next Command Register" contains the next instruction to the machine.

The computer is installed in three cabinets mounted on ball-bearing swivel casters. The cabinet containing the magnetic drum memory is 28 in. deep × 34 in. wide × 64 in. high and weighs approximately 380 lb. The cabinet containing the power supply is the same size and weighs approximately 520 lb. The cabinet containing the logical elements of the computer is 28 in. deep × 48 in. wide and 64 in. high and weighs approximately 500 lb. The machine will operate from either a standard 110 or 220-volt, 60-cycle, single-phase outlet. Internal fans cool the computer to normal room temperature. ALWAC is guaranteed for one-year against failure which occurs as the result of normal usage. Users receive scheduled maintenance service for one year. Unlike other computers which are leased, the company is selling ALWAC on outright purchase at $48,000 FOB, Redondo Beach.

#### Small Firms Can Use

Glenn E. Hagen, president of the company, feels that firms with as few as 500 employees could justify the purchase of an electronic data-handling machine such as ALWAC. The machine pays for itself by increasing product output by better utilization of productive facilities. He said that it can anticipate production bottlenecks and make decisions for correction; assign shop orders to machine tools and determine what is likely to happen in the shop for each hour for months at a time; and reduce overhead by doing the work of scores of clerks.

Other jobs for ALWAC in the factory, cited by Mr. Hagen, include inventory control, production control, cost accounting, deciding what to manufacture, and when, to meet a frequently changing production schedule, setting piecework prices, preparing manufacturing-cost estimates, scheduling of manufacturing operations, and controlling machine-tool operations.

## Optical Pyrometer

An optical pyrometer that measures the instantaneous temperature of flames in rocket and other combustion engines has been devised by physicists in the Research Division of New York University's College of Engineering.

The new pyrometer, which represents an important technique for studying the efficiency of engines, was described at the annual convention of the American Rocket Society, in New York, N. Y., by Dr. John H. Hett. Dr. Hett and research associate J. B. Gilstein developed the instrument and successfully applied it to the determination of rocket exhaust and combustion-chamber temperatures.

The pyrometer, Dr. Hett reported, allows engineers to follow the temperature in engines as it fluctuates throughout the complete engine cycle. This method of evaluating engine efficiency will contribute a basis for engine design and improvement.

Although NYU research centered on jets and rockets, the pyrometer can be applied to the examination of all types of luminous flames, Dr. Hett noted, and is therefore useful in studies of combustion engines from the ordinary home oil burner to rocket engines.

In tests with the instrument, sponsored by the Navy and Air Force, instantaneous temperatures measured were generally lower than had been predicted by theory.

The instrument employs the "two-path" technique, using two photoelectric cells. Acting as pickups, the cells "look" along almost the same line of sight. One looks to a black background. The other looks through the flame to a mirror and "sees" a flame thickness twice that of the first cell. The instrument eliminates the necessity of knowing explicitly the flame emissivity.

## Conveyer-Belt Sorter

An improved electromechanical machine for sorting physical objects into a large number of categories recently has been developed by the National Bureau of Standards, Washington, D. C. Designed by J. Rabinow of the NBS electromechanical ordnance laboratory at the request of the Bureau of Census, the device was built to sort punched cards at the rate of 420 cards per minute. The principle, however, is applicable to sorting such other objects as mail, electrical and mechanical components, and even farm produce, as well as checks, invoices, and other papers. Any items that can be separated into a number of subdivisions can be handled by an electromechanical system similar to the NBS sorter.

### Major Components

The NBS machine consists of five major components: (1) A sensing unit that reads the data-bearing cards and decides where they should go; (2) an addressing device that loads the conveyer with the cards and their corresponding address numbers; (3) a conveyer belt that carries both the card and its address number; (4) a series of recognition devices, actuated by the information-bearing mechanism of the conveyer belt, which operate trip mechanisms so that the cards are released from the conveyer; and (5) a series of receptacles, or gates to other devices, into which the material borne by the conveyer is sorted.

The NBS machine contains a track on which the cards are pushed by fingers extending down from the conveyer belt directly above. The conveyer belt conveys information in coded form, and the cards are kept in the correct physical location with respect to the address number by the pusher fingers. The conveyer belt is made from two parallel chains whose links are four inches on center and are connected by a crossbar at each card position. Each crossbar carries two nylon wheels on which the chains travel and eight nylon cams that act as the mechanical binary address number.

Each of the cams can be set to one of two positions (corresponding to the binary "zero" or "one") with the point either down or up. They arrive at the starting end of the conveyer in the clear or zero position. If it is necessary to tip the cam upward so that it becomes the equivalent of the binary one, a pawl is moved into its path. Eight cams, each with two possible positions, provide $2^8$ or 256 possible binary addresses. Since, in general, there are $2^n$ different addresses possible with $n$ cams, it can be seen that the number of categories into which a quantity of items may be sorted is limited only by the number of cams carried by the crossbars connecting the two chains.

### Safety Operation

In the sorting operation, the cards are first dealt from the bottom of the stack and pass under a conventional 80-column card reader. When the information on the card is decoded, an electrical device decides into which pocket the card is to go, and the cams are set up with the correct address number. The card is then pushed onto the track. As the cams move down the conveyer with their associated cards, they pass under a series of switches, one set at each pocket. A cam in the upward position will actuate a switch; one in the downward position will not. By properly wiring a set of eight switches, any particular 8-digit binary address number can be recognized, exciting a mechanism that will deflect the card from the track into a pocket.

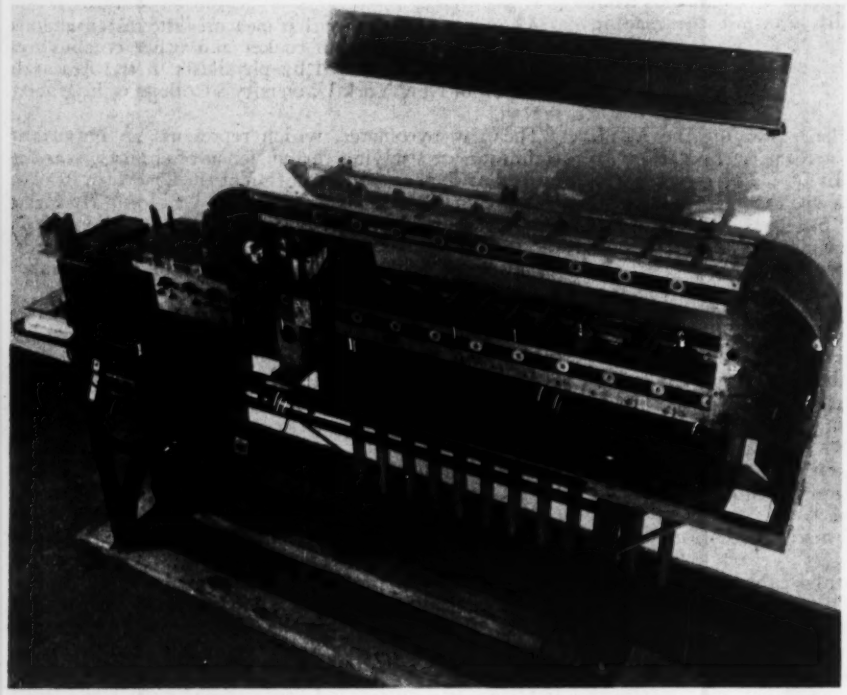


**Fig. 8 Conveyer-belt sorter developed at the National Bureau of Standards to sort punched cards. While this model has only 10 pockets in which to drop the sorted cards, machines with a much larger number of categories can be built using the same principles of operation.**

While conveyer-belt sorters of this general type are not new, the NBS machine is said to have several definite advantages. It is not a synchronous machine; that is, the card spacing in the conveyer does not have any relation to the spacing of the pockets. This leads to a saving in the power supply inasmuch as the cards cannot all be dropped simultaneously. However, if the pockets were to have the same spacing as the cards on the conveyer belt, then the cards could be dropped

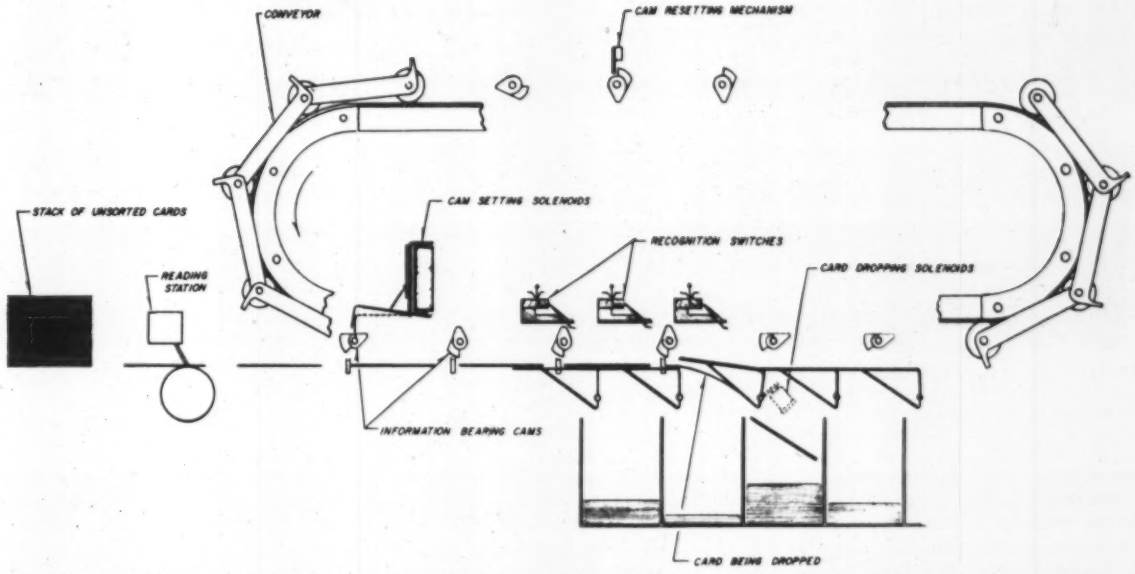



Fig. 9 Schematic diagram of the NBS conveyer-belt sorter. When the recognition switches are actuated by the cams on the conveyer, the card is dropped into the pocket below.

simultaneously although this normally would not occur. Large sections of the belt may be added, as well as groups of pockets in any desired spacing, but the recognizing element in all cases must be spaced a constant distance from its associated pocket. It is also a simple matter to provide more than one pocket for one category; when one pocket fills, subsequent cards can be deposited in a second pocket. Moreover, it is relatively easy to provide a counter associated with each pocket.

If a machine similar to the NBS model were to be designed for sorting mail, it is expected that for some time to come human operators would have to read the addresses on the letters. By means of suitable keyboards, the operators would set up the conveyer belt as the mail is fed into the conveyer. As the speed of the conveyer would normally be much higher than could possibly be matched by one operator, several people would be placed along the belt to feed it. Each operator would set up a series of pawls corresponding to the address on his letter and would then press a transfer key. The conveyer belt cams would be set up, and the letter (or package) would be inserted into the conveyer at the same time. It would be quite simple to provide an additional cam in each set to indicate that a particular space is filled; this would prevent a letter from being transferred until an empty section had arrived at the feeding station.

## 4½-Mile Conveyer Belt

One of the world's longest permanent rubber-conveyer-belt systems is now transporting coal from a strip mine near Beverly, Ohio. Installed by the B. F. Goodrich Company, Akron, Ohio, the rubber belt transports 800 tons of coal per hour over a $4^1/_2$-mile twisting, up-hill-down-dale course from the strip mine to the coal storage area of the Ohio Power Company's new 400,000-kw Muskingum River Plant. To reach its destination, the belt road bridges county roads, spans a state highway, and crosses the 500-ft-wide Muskingum River.

The entire conveyer system is composed of 14 flights,

Fig. 10 Rubber belt road takes rough terrain in stride. Foreground flight of belt climbs at an angle of 12 deg.

**Fig. 11 Here the belt road bridges a country road and descends to the rolling countryside below. From this point the belt road has 1 1/2 miles more to go before reaching the Muskingum River.**

or sections, of rubber conveyer belting, ranging in length from 500 ft to 2964 ft, pulley-to-pulley distance. The belts are 36 in. wide and travel at a speed of 600 fpm. Highest incline angle traversed is 12 deg; greatest decline is 12 deg. Transfer points located where one belt flight ends and another begins automatically cause the coal to discharge from one belt to another.

As the coal is mined, it is loaded by electric shovels and transported to a preparation plant, where the coal is crushed and washed. Emerging from this process, the crushed coal is ready for its journey to the river stock-piling area.

The 14 conveyer-drive motors are capable of producing a total of 1435 hp. To install the 48,000 ft of rubber belting needed for the belt road, 50 rolls of belting, weighing up to 4 1/2 tons each, were hauled to the site by motor freight from the B. F. Goodrich Company's Akron plant. A portable electric vulcanizer, weighing more than a ton, is used to make the vulcanized splices which make the belts endless.

## Machining and Grinding

DEVELOPMENTS of new processes for machining and grinding, as possible alternates to the use of diamond bort, have made very rapid advances during the period January 1, 1952, to July 1, 1953, according to the second report on "New Processes for Machining and Grinding," issued by the Minerals and Metals Advisory Board of The National Research Council and the GSA, Emergency Procurement Service. Research and development on new processes for machining and grinding has been sponsored principally by industry at a current rate of approximately $2,000,000 a year, the report states. Research and development effort has been increasing rapidly each year during the past few years and the rate of increase is expected to continue. The emphasis of the research and development effort on various applications of the new processes is not entirely compatible with distribution of diamond-bort consumption. To bring the development effort into closer balance with diamond-bort usage, more emphasis should be placed on processes for sharpening milling cutters, broaches, and fluted tools, and surface, cylindrical, and internal grinding (cemented carbides), the report states.

### Processes Under Consideration

The first report, MAB-18-M, "New Processes for Machining and Grinding" (MECHANICAL ENGINEERING, June, 1952, pp. 499–501), describes the principles involved in the electrolytic, electrosparking, electroarcing, and ultrasonic processes. Since then, developments have justified grouping the electrosparking process and the electroarcing process in one class—the electrodischarge processes. In addition to those processes described in MAB-18-M, two other processes now merit evaluation, namely, silicon carbide belt grinding and silicon-carbide wheel grinding. Finally, improved diamond-wheel grinding must also be included for evaluation, not only as a basis for comparison, but also because improvements in wheels, machines, and techniques have contributed to the conservation of diamond bort.

### Silicon-Carbide and Diamond-Wheel Grinding

The report points out that research and development on silicon-carbide wheel grinding and diamond-wheel grinding have not been increased over the past few years. Developments of both these processes have been going on for a number of years, and the most significant developments in recent years have been on more efficient use of wheels. For example, the so-called plunge-cut method, using narrow-width diamond grinding wheels to machine cut, with one pass, as deep as 0.1 in., appears promising for conservation of diamond bort, and much more research and development work can be done on this technique to improve and extend its applications. Other developments in the use of diamond grinding wheels include the more extensive and intelligent application of coolants. Developments in improving the diamond wheel itself have been accomplished mostly

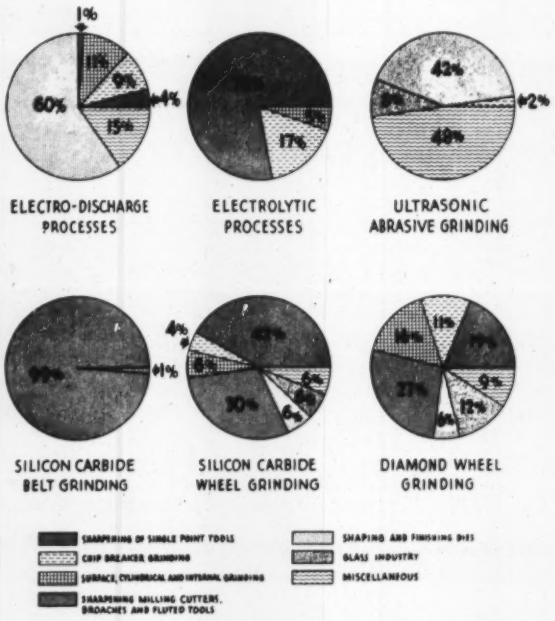



**Fig. 12 Research and development efforts for each process**

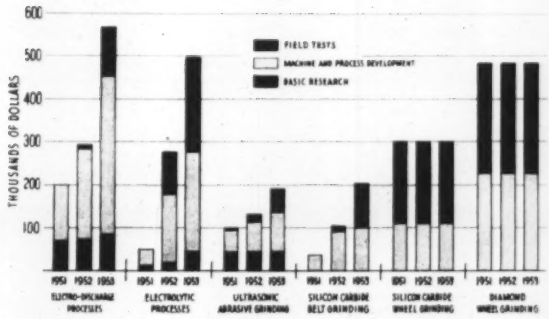



**Fig. 13 Research and development volume for each process**

through the development of superior bonds and by methods for inserting grains. An excellent example of the development of superior bonds is that of the vitrified bond for diamond wheels, with that product fully proved in the field. The development of the so-called single-layer diamond wheel has yet to be fully proved in the field. Continued developments along these and other lines will stretch considerably the available supply of diamond bort.

Silicon-carbide wheel-grinding developments over the past several years have been principally improvements in the bonds. The more extensive use of the green silicon carbide grain has also been a significant step for improved grinding of cemented carbides. Some development efforts currently are being placed on applications of silicon-carbide grinding wheels for sharpening milling cutters, broaches, and fluted tools. Another direction of development is in the area of new techniques in applying coolants. An example of this is the technique where the coolant is passed through a porous wheel. Further developments of improved bonds, use of coolants or lubricants, and techniques in the use of silicon-carbide wheels undoubtedly will increase the application of silicon-carbide wheels for operations where diamond bort currently is being used.

Silicon-carbide belt grinding has been introduced recently for finishing single-point tools and shows a very high rate of increase in research and development since 1951, with most of the increase in the field-test area. (Silicon-carbide belt grinding is being used extensively in the glass industry.) Improvements in grains, bonds, machines, and techniques in its use are indicated as the areas of most profitable research for further development of silicon-carbide belt grinding.

Ultrasonic abrasive grinding processes have experienced appreciable increase in research and development, particularly in the field-test area. Continued development work is being extended with emphasis on applications of field tests.

### Electrolytic Processes

Electrolytic processes have experienced a tenfold increase in research and development volume since 1951. Most of the emphasis in research and development on electrolytic processes has been in the areas of machine development and field tests. Field tests have emphasized sharpening of single-point tools, and results thus far are encouraging, particularly in that considerable savings of diamond bort for this application are indicated. Although metal-bonded diamond wheels are still being used with electrolysis, savings ranging from 60 to 95 per cent of diamond bort for this application might be realized. Electrolytes, consisting of sodium nitrite-sodium nitrate types, have been principally studied, with some work on sodium silicates. Also, methods of introducing the electrolytes have been improved. Another area of research and development has been in electronics, for developing rectifier power units to minimize arcing and to extend the use to much higher current densities. Continued efforts along these general routes undoubtedly will provide marked improvements in electrolytic processes.

Current research and development volume on electrodischarge processes is higher than on any other class of process. Most of the development work has been in machine developments and field tests since 1951. However, application developments have not emphasized those operations accounting for the greater part of diamond-bort consumption. Instead, they are being applied to operations where they are peculiarly adaptable, such as in shaping and finishing dies and miscellaneous operations. A great deal has yet to be done in application to those other operations where relatively large quantities of diamond bort currently are being consumed. Recent significant developments have been in improving the quality of finish, compatible with high rates of stock removal. Progress has been made in improved circuits, servomechanisms, and precision. Further developments in these directions, and engineering for reduction of cost of the machines appear to be most pertinent.

Trade acceptance of new processes is a problem and, in some cases, more difficult to resolve than the technological problems. Adequate facilities for field-test work in industry are lacking, and improvements in field-test work should accelerate the bringing of new processes into production use.

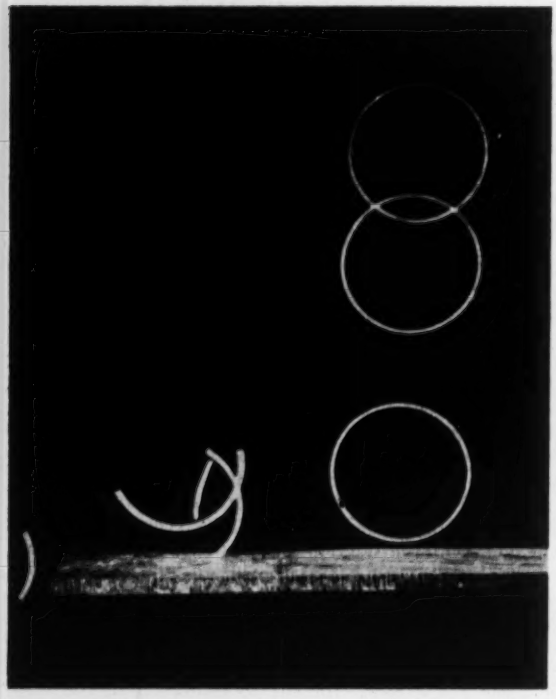
## How to Obtain Further Information on "Briefing the Record" Items

**Material for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.**

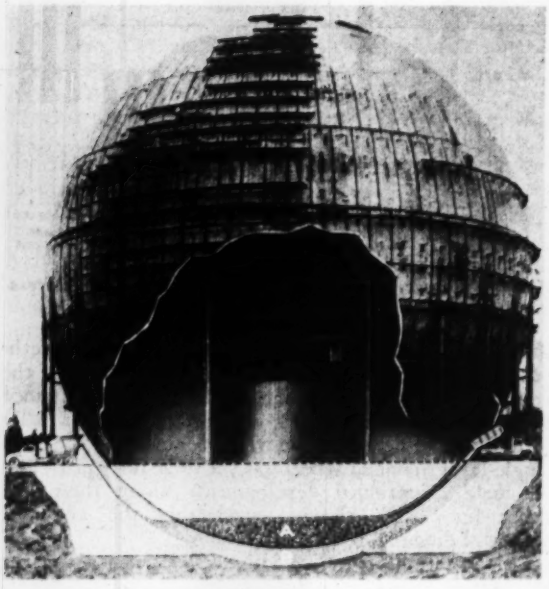
**This material is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.**

**For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources; i.e. (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at usual rates, 40 cents per page.**

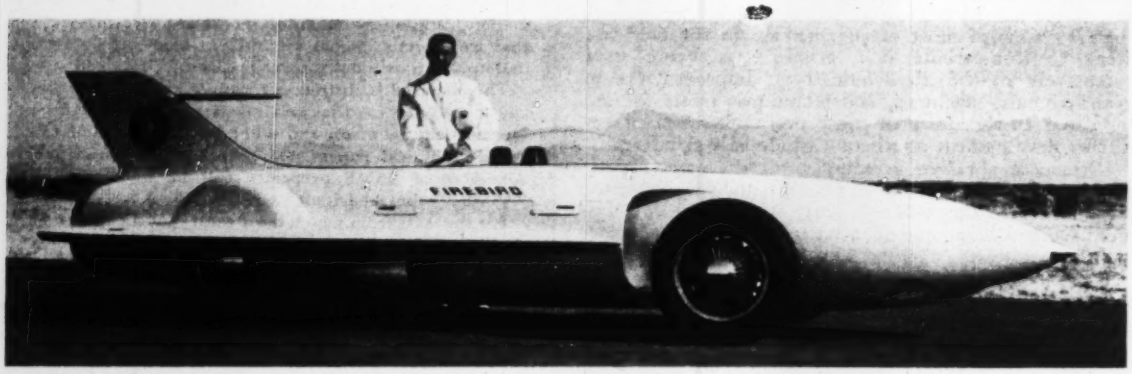
# Engineering developments . . .



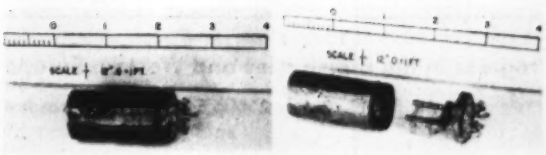
**Bouncing Cast Iron.** Stroboscopic photograph shows two cast-iron pipe sections dropped, from a height of 20 ft, shortly after contact with a steel plate. The ordinary gray-iron section breaks into pieces, while Ductile Iron, *right*, shoots upward in bounce pattern. A development of The International Nickel Company, Inc., Ductile Iron is a magnesium-containing cast iron which is not brittle, and can be bent or twisted. The novel product has several times greater strength than ordinary cast iron with ductility and shock-resistance. Ductile Iron is being used for many jet-engine components, glass molds and plungers, tire molds, gun components and tank parts, Navy shipboard applications, crankshafts, pistons, and heads. It is also finding use in the textile, chemical, petroleum, mining, lumber, and steel industries.



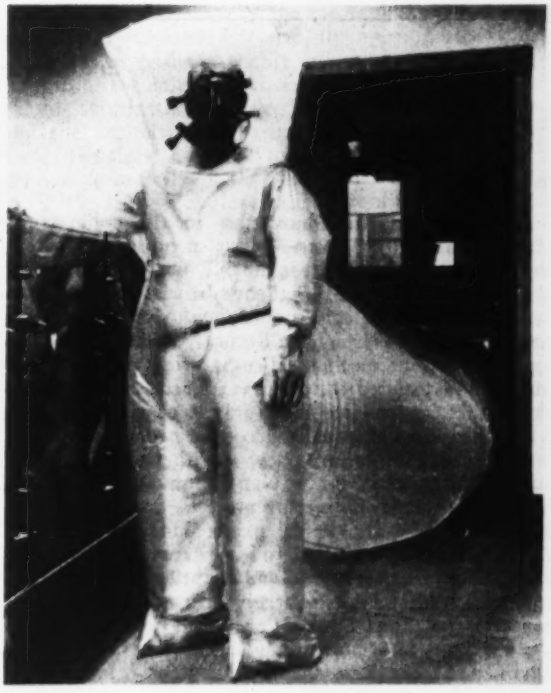
**Atomic Submarine Reactor Sphere.** This cross section pictures one of the nation's most difficult flooring jobs—for the Atomic Energy Commission's Mark A Submarine Intermediate Reactor (SIR) for the U. S. Navy's *Sea Wolf*. The Rust Engineering Company, Pittsburgh, Pa., is placing 28,000 tons of crushed limestone, A, inside the 20-story spherical steel housing to fill it up to the dotted line providing ballast and floor space. Underneath, the 4-ft space between the sphere and foundation is being filled with 3900 cu yd of concrete, B. To avoid stresses that might break the huge globe's 1-in. skin or distort its shape, the engineers poured a 3-ft layer of limestone inside, one day, and a 3-ft layer of concrete outside the next, allowing neither material to rise more than 18 in. above the level of the other. The 3850-ton steel ball, supported at its equator by 26 steel columns, was built above its bed to allow space for working and testing during construction. Located at West Milton, N. Y., the SIR Mark A project is under the direction of the Knolls Atomic Power Laboratory at Schenectady, N. Y., which is operated for the AEC by the General Electric Company.




**Gas-Turbine Auto.** This is General Motors' XP-21 Firebird, first gas-turbine automobile built and tested in the United States. An experimental vehicle for proving-ground and test-track driving only, the Firebird has an aircraft motif in its unique styling. It is a single seater with a plastic bubble over the driver's cockpit. Behind the driver is the engine which consists of two mechanically independent parts: the gasifier section and power section. The gasifier section provides a source of compressed hot gas, and energy from this gas is delivered by the power section to the car's rear wheels. The Whirlfire engine develops 370 hp when the gasifier turbine is spinning at 26,000 rpm and the power turbine is revolving at 13,000 rpm. Total weight of the engine unit, including gasifier and power sections, is only 775 lb. Over-all weight of the entire car is 2500 lb. The entire engine fits into a space 63 in. long, 26 in. deep, and 32 in. wide.

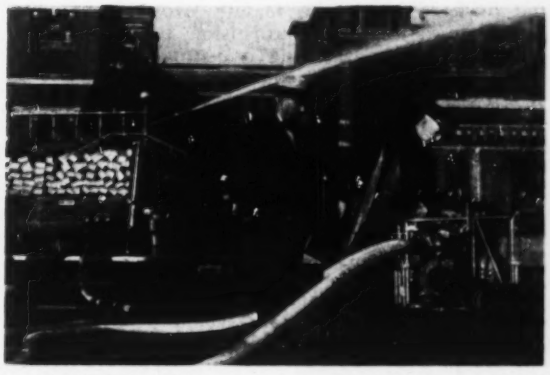


**Hot Midget Mathematician.** This subminiature analog-computer component has been developed by Arma Corporation at Roosevelt Field, Garden City, N. Y. Based on heat-transfer principles, this component essentially makes use of a transducer in which an incoming electrical signal is dissipated into heat. The temperature differential thus created is communicated to a pair of temperature-sensitive conductors mounted in a Wheatstone bridge. The output of the transducer is a direct function of the amount of unbalance caused in the Wheatstone bridge; it is also proportional to a reference signal, supplied to the bridge for the sake of detecting the unbalance. Termed "Hot Midget Mathematician," this instrument component—without moving parts—adds, subtracts, multiplies, divides, integrates, and performs operations of vector algebra and vector calculus automatically. Opened, the computer component appears about as simple as the plug and socket for an electrical appliance.



**Atomic Suit.** Latest General Electric atomic attire now in vogue at the huge plutonium-producing plant at Richland, Wash., operated by G.E. for the Atomic Energy Commission, is this atomic suit. Plastic, balloonlike suit provides protective barrier against radiation in "hot" areas and permits a man to determine extent of contamination and do clean-up and maintenance work in such areas. "Train" in rear is a flexible plastic tunnel leading from suit to entrance port in wall. It provides air and serves as an entrance and exit passage. Air mask worn is used only if, by some accident, the suit becomes torn or punctured.

**Relief-Well Flowmeter.** Pictured here is an improved meter for measuring flow in pressure-relief wells, recently developed by the Corps of Engineers' Waterways Experiment Station at Vicksburg, Miss. These wells, installed at the toe of earth dams and behind levees, intercept seepage and provide relief for excess hydrostatic pressures in pervious strata beneath the structures. Measurements of seepage flow into the wells from various strata as well as total flow are obtainable with the meter. The flowmeter, essentially a vertically operating current meter, is used to measure flow by observing (electrically) the rate of revolution of an 8-bladed aluminum impeller mounted in a guard ring. The meter is provided with a spring-leaf adapter, adjustable to various well diameters, which centers the meter in operating position. The meter is lowered into the well on a cable in order to measure flow at any desired depth. Components of the meter—impeller assembly, suspension rod and adapter, earphones, battery, and cable drum—are transported in a compartmented chest. The meter is calibrated in relief-well pipes of appropriate diameters by counting rates of revolution for known flows through the pipe. Meters constructed for the St. Louis District, and for the use of Waterways Experiment Station field parties, have been calibrated in 6 and 8-in. pipes and show linear operation accurate to better than 3 per cent of flow over a range from 10 to 1000 gpm.



**Gas-Turbine Fire Pump.** The fire hose shooting 500 gpm of water into the East River in New York, N. Y., is being fed by the tiny gas-turbine-driven fire pump, *right*, designed and manufactured by Solar Aircraft Company, San Diego, Calif. New York, N. Y., officials examine the powerful new aid to firefighting at a recent demonstration. A 50-hp engine, the Solar Mars gas turbine is used to power the fire pump, originally produced for Navy use as a shipboard fire pump. The complete pump units are hand-started, easily portable, require little maintenance, and operate on a variety of fuels.

# European Survey

## Engineering Progress in the British Isles and Western Europe

J. Foster Petree,[1] Mem. ASME, *European Correspondent*

### Innovation

THIS feature is an innovation in the columns of MECHANICAL ENGINEERING and, as such, deserves a few words of introduction. It is the outcome of an idea that has been often discussed, that the editorial staff ought to include a European correspondent who could indicate, on the lines of "Briefing the Record," some of the high lights of current mechanical-engineering progress, and the many associated factors that influence it, in a Continent that has suffered much in the past 15 years but which has now practically accomplished its comeback into normal production. New machine tools and production machinery, power-plant equipment, new materials, important engineering projects, news of research activities—these are typical of the kinds of topics on which it is hoped to report, to some extent in the form of abstracts from the technical and scientific journals of the countries concerned, but largely also through personal contacts and direct observation. The broad outline of the coverage, as at present envisaged, may require to be modified to meet the wishes of readers, or, it may be, for practical reasons that have still to emerge. So much is going on in Western Europe, however, that is of interest to mechanical engineers, that it is felt some notice, however brief, should be taken of it in MECHANICAL ENGINEERING.

### Two-Stroke Marine Diesel Engine

THE Dutch engineering firm of Stork Brothers (Koninklijke Machinefabriek Gebr. Stork, N.V.) of Hengelo, who hitherto have built mainly two-stroke double-acting engines for marine propulsion, have constructed a supercharged single-acting two-stroke engine, with uniflow scavenging. The engine is shown in Fig. 1 on the test bed in their works and is being fitted in the cargo motorship *Ouderkerk*, under construction by the Netherlands Dock and Shipbuilding Company for the Vereenigte Nederlandsche Scheepvaart Maatschappij. The engine has eight cylinders, 750-mm bore, and 1500-mm stroke and is rated at 8500 bhp at 115 rpm. Without the supercharger, the output is 7200 bhp at the same speed. The shape of the combustion chamber is generally similar to that of the well-known Stork-Hesselman engine, but four small exhaust valves are provided instead of one large valve; they are symmetrically disposed round the central inlet valve and are operated by push rods and levers from the camshaft. The starting-air valves are pneumatically operated under the control of small pilot slide valves, also actuated by the camshaft. Scavenging air is supplied by four Brown Boveri turbo-blowers, each driven by the exhaust gases from two of the engine cylinders. The weight of the engine without the supercharger is 62.5 kg per bhp; including the supercharger, it weighs 50 kg per bhp of the larger supercharged output. On test, the fuel consumption at full load without supercharging was about 155 gm per bhp per hour, and about 5 per cent less with the supercharger in use. When idling, steady running could be maintained at a speed as low as 18 rpm.

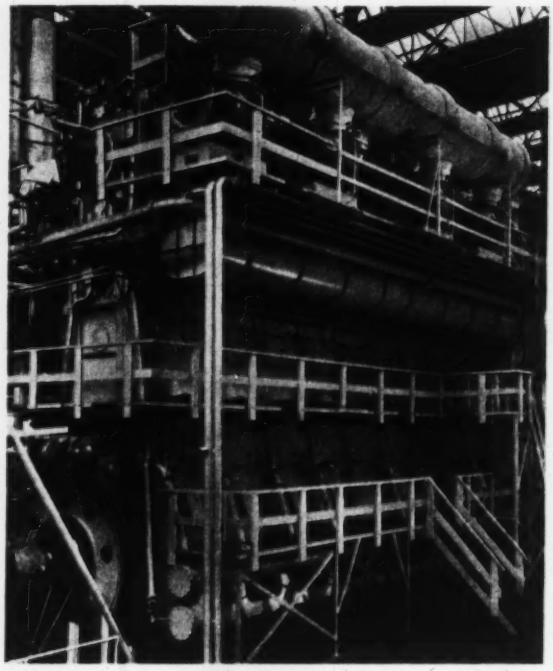


Fig. 1 Supercharged single-acting two-stroke marine diesel engine with uniflow scavenging

### End of an Experiment

A TOPIC that has attracted considerable attention in London, England, is the decision of the London County Council not to take over from the British Ministry of Fuel and Power the experimental heat pump—the largest in the world—that was installed by the Ministry in 1951 to heat, or alternatively to cool, the Royal Festival Hall. It is to be replaced by a plant of more orthodox design, as its operation has proved to be uneconomic. The heat pump was an object of much interest to scientifically inclined visitors to the Festival of Britain exhibition, held in 1951, on the south bank of the river Thames, opposite Westminster, on a site bisected by the railway viaduct leading to Charing Cross Bridge. One of the

[1] Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.

arches of the viaduct was used to accommodate the plant, which is driven by two Rolls-Royce "Merlin" airplane engines, running on town gas and giving an output of about 350 bhp each. As the loading was so light, the engines were modified by the removal of their superchargers, the rotating parts of which were used in the construction of the two compressors; these are connected in series, one compressor being driven by each engine. The refrigerant used is Freon 12. The purpose of the plant was to extract low-grade heat from the river water to warm the Festival Hall, or, as the conditions required, to reverse the process and extract heat from the atmosphere within the Hall. The engines run at about 2000 rpm and are coupled through gearing to the compressors, which run at about 14,000 rpm.

The application was not an ideal one for a heat pump, as the Hall is used intermittently, by audiences varying greatly in numbers. Moreover, the construction of the building, which had to be heavily sound-insulated to keep out the noise of railway traffic on the adjacent viaduct, made the prediction of the load somewhat problematical. Experience showed that it had been considerably overestimated, according to a paper read before The Institute of Fuel in London by P. E. Montagnon, of the Ministry of Fuel and Power, who designed the installation, and A. L. Ruckley. The estimate was that the peak load might reach 25 million Btu per hour, whereas in practice the peak barely reached 9 million Btu and the normal load was several million Btu lower than that. Further, the characteristics of the centrifugal compressors prevented any material variation of the mass flow through them, so that the heat output from the system was virtually fixed. In such circumstances, sustained running at high efficiency was almost impossible to obtain. The cost of the plant was £103,200 of which £39,000 was expended on the development and installation of the engines and the compressors.

## Oil Burner for Varying Loads

A NEW type of fuel-oil burner in which the fuel-air ratio is maintained automatically under varying loads has been developed by White's Marine Engineering Company, Limited, of Hebburn-on-Tyne, England, and is described in *Engineering* (London), of Jan. 15, 1954. Referring to Fig. 2, the oil burner operates as follows: Oil is admitted through the central tube, which can be advanced or withdrawn axially by a pinion engaging with a rack on the side of the tube. The oil enters the tube through a tapered groove, the opening of which is varied by its position within an annular seal. The air flow from the inlet branch is divided, the primary air passing within the fixed sleeve surrounding the oil tube, and the secondary air through the annular space between the sleeve and the burner casing. The oil leaves the nozzle radially in the form of a sheet about 0.006 in. thick, at right angles to the flow of primary air, the impact of which atomizes it. As the mixture of primary air and atomized oil issues from the burner, it is further mixed with the secondary air. Angled vanes in the air passages impart a swirl to the air, the secondary air stream being rotated in the opposite direction to the primary air. The control seal round the oil-inlet groove is mounted in an axially adjustable carrier, so that its position can be varied to suit oils of differing specific gravity or viscosity. The burner can be provided with automatic control by the addition of a thermostat and a servo system to operate the regulating lever. The standard range of sizes covers oil consumptions from $1\frac{1}{2}$ gal to 40 gal an hour.

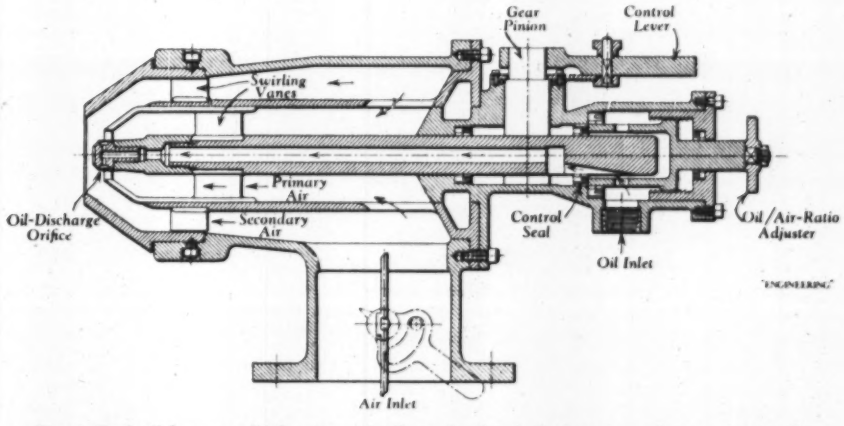


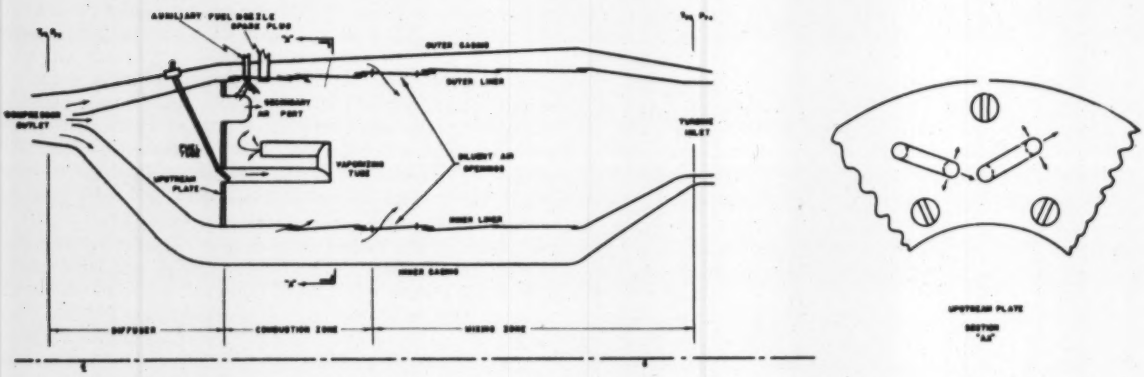

Fig. 2 Fuel-oil burner which automatically maintains fuel-air ratio under varying loads

## Origins of Mechanical Servomechanisms

THE foregoing application of a servomechanism to control an oil burner is typical of many uses now being found for this kind of device, the design and manufacture of which is developing almost into a separate branch of engineering, with an extensive literature of its own. Yet the idea of a mechanical servo, in the sense of a power-amplifying system in which the output is related to the input as to position, speed, or otherwise, is at least a century old, and the germ of it can be traced back for another century or more. H. G. Conway recently read a paper on the subject before the (British) Newcomen Society for the Study of the History of Engineering and Technology (the parent body from which "American Newcomen" has grown) in which he showed that mechanical servo systems effectively began with steam steering gears for ships and that the originator of this type was F. E. Sickels, of New York, whose steering gear was the subject of U. S. Patents 9713/1853 and 2920/1860. The term "servo motor," however, was invented about 1870 by a Frenchman, Joseph Farcot, who was the first man to write a book about them. Conway found that the historical study of the subject was much complicated by the difficulty of defining "servomechanism" with any precision; and he quoted, with feeling, a comment, in the *Scientific American* for September, 1952, that, "It is nearly as hard for the practitioners of the servo art to agree on a definition as it is for a group of theologians to agree on sin."

# *ASME Technical Digest*

**Substance in Brief of Papers Presented at ASME Meetings**



Schematic diagram of vaporizing combustion chamber with annular-type burner for aviation gas-turbine engines

## Aviation

**Characteristics of a Vaporizing Combustor for Aviation Gas Turbines,** by W. D. Pouchot and J. R. Hamm, Assoc. Mem. ASME, Westinghouse Electric Corporation, Philadelphia, Pa. 1953 ASME Annual Meeting paper No. **53—A-182** (mimeographed; available to Oct. 1, 1954; to be published in Trans. ASME).

THE vaporization of liquid fuel prior to its introduction into the burning space has been used in many kinds of combustion chambers, and was an attractive possibility from the beginning for aircraft gas-turbine use. However, most attempts to use such a method were beset with difficulty and abandoned in favor of liquid-fuel injection.

This paper presents the tested characteristics of a vaporizing combustion chamber which has been developed to the point where it has met satisfactorily the requirements of the modern jet engine and is being used in field service. The requirements may be stated quite simply: It should be highly efficient, stable, and capable of ignition over a wide range of operating conditions, light in weight, small in size, durable, requiring a minimum of maintenance, and have no harmful effect on other components.

This vaporizing combustor was found to have the following desirable qualities: (a) It can be of very short length and still maintain good efficiency and stability because of the removal of the time for vaporization from the combustion time; (b) it is clean burning using a wide range of fuels which results in low wall deposits and low luminosity of the flame, thereby reducing wall temperatures; and (c) it can use extremely low fuel pressure without performance penalty. Its chief virtue in our eyes is a 40 per cent saving in burning length over over a comparable liquid-injection burner which was developed for the same application.

During the starting cycle, the vaporizing combustor requires auxiliary liquid fuel-injection nozzles. The use of these nozzles insures prompt ignition and good starting by eliminating the reluctance to ignite and the tendency to torching on the bottom half of the burner which is characteristic of the vaporizing combustor before its vaporizer elements have reached operating temperature. The auxiliary nozzles operate only during the starting cycle. After the vaporizer elements reach operating temperature, the combustor's response to fuel-rate changes is excellent.

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**Mechanical Features of the Tandem Helicopter Drive System,** by W. F. Plume, Piasecki Helicopter Corporation, Morton, Pa. 1953 ASME Annual Meeting paper No. **53—A-214** (mimeographed; available to Oct. 1, 1954; to be published in Trans. ASME).

THE development of the helicopter has opened up an entirely new concept of flight and its application to military and civilian uses, but at the same time has introduced mechanical problems not encountered in any other type of machine. The low-speed rotors on vertical shafts are driven by engines buried in the fuselage requiring not only high-ratio gearing but also angular drives and long connecting shafting. The high inertia of the rotors also requires a clutch which will permit starting the engine without load. After warm-up the rotors are started with the engine turning at idling speed. In addition to these requirements, there must be an overrunning clutch in the system so that in event of engine failure the rotors will continue to turn freely to permit an autorotative landing.

In the shaft-driven helicopter, drive-system reliability plays a large part in the safety of the helicopter. Drive-system reliability is established by extensive development testing and is maintained by quality control and production load runs. This paper describes in detail the transmissions and clutches of two types of tandem-rotor helicopters and the methods used for testing.

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**Design and Development Problems in Large Helicopter Power-Transmission Systems,** by W. P. Robinson, W. P. Robinson Company, Lockport, N. Y., and J. H. Yost, Bell Aircraft Corporation, Buffalo, N. Y. 1953 ASME Annual Meeting paper No. **53—A-224** (mimeographed; available to Oct. 1, 1954).

This paper specifically covers the Bell Model 61, or Navy HSL-1, helicopter, but the design and development problems are, in general, typical of those for

any large tandem rotor helicopter. The paper outlines the over-all design and then describes in detail some of the problems that had to be overcome during the development test program.

The particular arrangement was selected after careful study of the requirements of the design, the most important of which is compactness. For shipboard operation the length of the fuselage is limited, and hence a maximum of power and lift must be packed into a minimum fuselage space. A long shaft that connects the two rotors is parallel to the roof of the fuselage. For future growth, it is thus very easy to lengthen the fuselage without changing any transmissions or the angles of any drive shafting.

The engine nose case is directed aft and somewhat upward. The upward tilt is dictated by the fact that the aft transmission must not be too low because of ground clearance during a flared landing.

**Dimensional Stability and Structural Integrity of Casings for Aircraft Gas Turbines,** by J. S. Alford, General Electric Company, Lockland, Ohio. 1953 ASME Annual Meeting paper No. 53—A-231 (mimeographed; available to Oct. 1, 1954).

Compressor casings made of five different cast light alloys were examined for diametrical distortions after one, two, and three 150-hr endurance tests on turbojet engines. The consequences of blade failure as regards structural integrity of casings is reviewed in light of operating experiences. Analysis and formulas are presented for casing stresses and deflections due to inertia loads and also nonuniform radial loads.

Some of the conclusions reached were as follows:

1 For the highest flight speeds, insulation and cooling of the casings containing compressor discharge air are necessary if materials having the highest ratios of strength to weight are to be used for the casings.

2 Compressor casings made of several different alloys of aluminum and magnesium have good, but not outstanding, dimensional stability for the particular application evaluated. The aluminum alloys investigated were better than the magnesium alloys tested.

3 In general, the deformation of the aluminum and magnesium casings did not increase with operating time. In some cases the deflection became less with increasing running time.

4 Casings should be able to withstand blade breakage without shattering around the full circumference.

5 When a casing is simply supported by endframes which remain perfect circles, the weight of the casing does not increase the out-of-roundness by any significant amount. This case of loading produces a membrane state of stress which results in a very small sag in the central axis of the casing.

6 When a casing is simply supported by endframes which remain perfect circles, a circumferentially nonuniform pressure loading, which has one wave in the complete circumference, does not increase the out-of-roundness by any significant amount. This case of loading produces a membrane state of stress which results in a very small sag in the central axis of the casing.

7 Endframes which consist of struts extending radially inward to a rigid hub may contribute but little stiffening effect on the casing if the struts should coincide with the nodes characteristic of the displacement pattern.

**The Rotary Wing Becomes the Air Truck,** by W. B. Bunker, Mem. ASME, T. C. Chief, Air Transport Service Division, U. S. Army, Washington, D. C. 1953 ASME Annual Meeting paper No. 53—A-238 (mimeographed; available to Oct. 1, 1954).

Thus far transport helicopter operations have been restricted to the approximately three-quarters of a ton capacity Sikorsky H-19. While this was a giant among helicopters a few years ago when it was first introduced, it is now generally considered too small for a cargo transport. To be placed in service in the next few months are the Piasecki H-21 and the Sikorsky H-34, which have twice the capacity of the H-19. These larger machines place the helicopter in a position to actually enter into the real cargo transportation field.

Under development are three and five-ton-capacity helicopters approaching the productive stage. With aircraft of these types it will be possible to perform over eight per cent of the cargo and troop movement requirements of an Army in the field. With machines of this size, it is certain that theh elicopter will be able to approach the operating economics for fixed wing aircraft.

The design of these new helicopters is approaching many of the characteristics which, commercial air transport operations have said, will be required to make a good helicopter of their services.

The next development in the helicopter field will probably be in the so-called converti-place field. This is a helicopter to which wings and propellers have been added or other changes introduced in order to increase the cruising speed and decrease the high vibrationary characteristics of current helicopter design. It is probable that some form of this development will offer significant improvement over the pure helicopter, and will replace it in time if the costs of the improvement can be kept at a low figure. In this development, however, the relative cost required to achieve these improvements must be most carefully weighed. While a high price can be paid for a relatively small improvement to a combat aircraft transport, equipment must compete on a purely economic basis. No trucker will pay twice as much for a new truck that can go 20 mph faster since practical considerations (and speed laws) will keep him from paying the increased costs by increased earnings. In the purely military application of the helicopter, it is expected that the true helicopter will have an advantage in operating economies over the combination.

While Army operations are conducted under entirely different conditions than are commercial ones, the vehicles required for successful commercial helicopter operations will be very similar to, if not identical with, the military. Both require operating efficiency if expressed in cost per ton mile or numbers of supporting equipment and personnel required. Both require a high degree of dependability, regularity of operation, and an efficient cargo carrier. The development of the Army transport helicopters has done much to advance the art and the industry toward the development of a good vehicle. Increased use of the machines will tend to lower their costs of ownership and operation which is the biggest single bar against their more extensive use today.

## Heat Transfer

**A Preliminary Note on the Correlation of the Viscosities of Gases and Other Fluids,** by E. J. LeFevre, Department of Scientific Industrial Research, Mechanical Engineering Research Laboratory, East Kilbride, Glasgow, Scotland. 1953 ASME Annual Meeting paper No. 53—A-192 (mimeographed; available to Oct. 1, 1954).

As part of the program of preparing tables of thermodynamic and transport properties of gases, gas-viscosity data have been correlated. The aim of this has been to find the form of function relating the viscosity of a gas to its temperature and then to adjust the constants of this function to suit the data available for each gas in turn.

Gas-viscosity data have been correlated by the use of critical data. The

viscosity of the great majority of gases can be predicted within about five per cent. This should be of use for many industrial calculations of heat transfer. A number of theoretical considerations are put forward and the results are shown to agree with the calculations of Kihara and Kotani, and of Hirschfelder, Bird, and Spotz.

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**An Accurate Method for the Determination of the Thermal Conductivity of Insulating Solids,** by C. R. Mischke, University of Kansas, Lawrence, Kan., and E. A. Farber, Assoc. Mem. ASME, University of Wisconsin, Madison, Wis. 1953 ASME Annual Meeting paper No. **53—A-185** (mimeographed; available to Oct. 1, 1954).

IN ORDER to provide a means for more accurately determining the thermal conductivity of insulating solids, a new apparatus was developed which removes objectionable characteristics of the conventional guard-ring hot plate and incorporates a boiling-liquid heat sink and a new approach to the problem of surface-temperature measurement. Some data are presented to demonstrate the nature of the performance of the new equipment. It is shown that the thermal conductivity can vary with the temperature in a distinctly nonlinear fashion.

The apparatus as developed will provide an instrument to aid in the development of a body of accurate conductivity data. Such a body of information will be of great use in the formulation of theories as to the mechanisms of conduction. The reproducibility of data and soundness of concept lead the authors to conclude that the instrument reports thermal conductivity to three significant figures. A boiling-liquid heat sink in the range used is considered superior to a circulated-liquid heat sink even with surge tanks and is, therefore, recommended for further work of this nature. The boiling-liquid heat sink is adaptable to a wide range of temperature by using boiling liquefied gases for low temperatures, boiling organic liquids for intermediate temperatures, and boiling metallic liquids for elevated temperatures. The thermometric technique used is recommended for additional work of this type.

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**The Theoretical Calculation of the Equation of State and Transport Properties of Gases and Liquids,** by R. B. Bird, Cornell University, Ithaca, N. Y., and J. O. Hirschfelder and C. F. Curtiss, University of Wisconsin, Madison, Wis. 1953 ASME Annual Meeting paper No. **53—A-87** (mimeographed; available to Oct. 1, 1954; to be published in Trans. ASME).

SEVERAL years ago a summary article was written about the theoretical calculation of the viscosity and several other properties of gases and gas mixtures. Since that time further calculations of the equation of state and transport coefficients of dense gases and liquids have been made. Although the statistical mechanical theory is an involved and highly mathematical topic, and although some of the numerical computations are quite complex, the final results nevertheless may be presented in terms of tabulated functions, which are easy to use in practical calculations. The formulas and tables given in this paper should prove useful in engineering design calculations and in chemical process studies. Furthermore, the underlying statistical mechanical theory whenever possible should be used to give intelligent interpretation to the analysis and correlation of chemical and engineering data on the properties of matter.

Statistical mechanics provides the means for relating the bulk properties of matter to the law of force which describes how two of the molecules in the substance interact with one another. The paper presents in the first section a short discussion of the nature of "intermolecular forces." The next two sections deal with the results of "equilibrium statistical mechanics"—the calculation of the equation of state of moderately dense gases, very dense gases, and liquids. Two other sections summarize some of the results of "nonequilibrium statistical mechanics" (more usually referred to as "kinetic theory")—the calculation of the coefficients of diffusion, viscosity, and thermal conductivity of dilute gases, dense gases, and liquids. It will be seen that for some properties the theoretical or computational work has not yet been sufficiently developed to be useful in practical calculations.

The final section presents a discussion of the "principle of corresponding states," which has as its basis simple dimensional arguments. This principle can be a powerful tool for predicting properties of gases and liquids in the absence of satisfactory theory, calculations, and experimental data. The paper presents the most important formulas and tabulated functions and indicates what additional theoretical and computational work may be found elsewhere in the literature.

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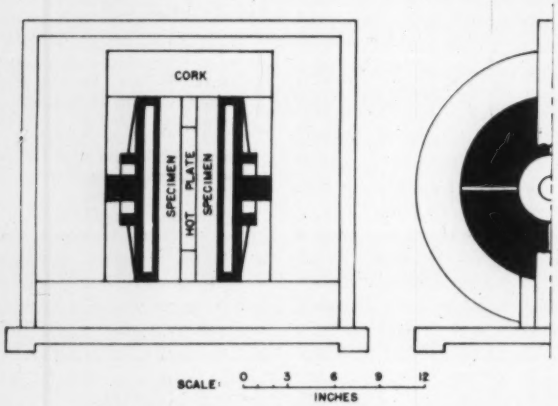
**Generalized *pvT* Properties of Gases,** by L. C. Nelson, Royal Cabell Fellow, and E. F. Obert, Mem. ASME, Northwestern Technological Institute, Evanston, Ill. 1953 ASME Annual Meeting paper No. **53—A-194** (mimeographed; available to Oct. 1, 1954; to be published in Trans. ASME).

IN ENGINEERING practice, reasonable approximations to the *pvT* relationships of a fluid are frequently required, especially for the case, more usual than unusual, where *pvT* data are entirely nonexistent. To fulfill this need, several generalized charts have been developed and are in use, principally in the chemical industries. Comparison of these charts reveals that either large differences are present or else the charts are closely similar. In the first instance, the divergences arose from the assumptions made in generalizing the *pvT* data or from the choice of data. In the second instance, the charts were based primarily upon one or two gases (usually, hydrogen and nitrogen), and the same compressibility data were used by the several authors. It is understandable that the validity of the older charts has not been too well




**Apparatus for accurate determination of thermal conductivity of insulating solids**

established when it is considered that the charts were developed some years ago, and even today, high-pressure data are extremely meager.

In this paper two sets of generalized compressibility charts are presented. One set is based upon critical temperatures and pressures as in the past. The second set is based upon pseudo-reduced co-ordinates obtainable from the Lennard-Jones force potential. In both sets the underlying data are more extensive than those used in constructing older charts since a complete survey of existing $pvT$ data was made. The results of this survey for 30 gases are contained in a Bibliography of 275 items which has been constructed to show the extent of the experimental data by including the ranges of pressure and temperature for each item. Although the charts are intended for engineering computations, the chart for the low-pressure region ($p_r = 0$ to 1), for example, has a deviation of one per cent for 26 gases.

The following conclusions were reached:

1 Generalized $pvT$ data should be based upon critical constants when the molecular structure of the fluid is complex or for polar molecules.

2 Generalized $pvT$ data can be correlated better by kinetic parameters when the molecular structures of the fluids are essentially spherical, and the molecules are essentially nonpolar, and quantum effects are negligible. This correlation is obtained in regions where the theoretical kinetic equations cannot be applied.

3 The regions where the Bird and Spotz tables are applicable, have been indicated in terms of the critical-constant parameters of reduced pressure and reduced temperature.

4 At temperatures below the Boyle point isotherm, $H_2$, He, and $D_2$ exhibit erratic behavior on either set of charts and the $pvT$ relationships should be obtained from compressibility data for the individual gases.

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**Survey of Experimental Determinations of Heat Capacity of Ten Technically Important Gases—Air, $NH_3$, $CO_2$, CO, $H_2$, $CH_4$, NO, $N_2$, $O_2$, $H_2O$,** by Joseph F. Masi, National Bureau of Standards, Washington, D. C. 1953 ASME Annual Meeting paper No. **53—A-206** (mimeographed; available to Oct. 1, 1954; to be published in Trans. ASME).

THE specific heat is one of the most important thermodynamic properties of pure substances, and at the same time it is one of those measurable in the laboratory to a degree of confidence proportional to the expenditure of care and the refinement of technique. In the particular case of gases, accurate heat capacity measurements, at several pressures and over a range of temperatures, are valuable in at least two ways. First, they may be extrapolated to zero pressure at the several temperatures to obtain a set of values of ideal-gas heat capacities. For gases of any complexity the heat capacities thus obtained may frequently be used to decide questions of structure or vibration frequency. Once a reliable set of molecular constants is available, the zero-pressure thermodynamic properties may be calculated over a temperature range far larger than that of the heat capacity experiments. Second, the values obtained for the change of heat capacity with pressure may be an order of magnitude more accurate than the same quantity calculated from data of state of good accuracy. Thus there is provided an opportunity to check or modify existing equations of state.

All of the literature reports of determinations of heat capacity of gases in the period 1925 to 1952, inclusive, have been reviewed, and those pertaining to any of the ten gases—air, $NH_3$, $CO_2$, CO, $H_2$, $CH_4$, NO, $N_2$, $O_2$, and $H_2O$—are tabulated. The four direct and six indirect methods used in these measurements are briefly described. By means of graphs, the reported results for several of the gases are compared with values calculated from molecular data and an equation of state. There is included a table of the most recent values of heat capacity at one atmosphere for the ten gases.

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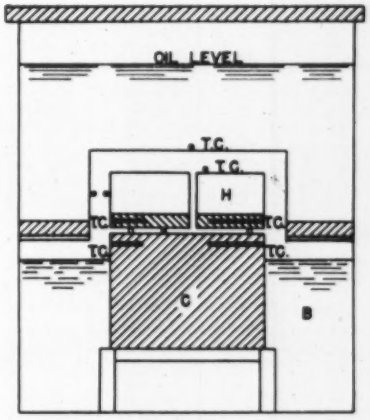
**The Thermal Conductivities of Some Organic Liquids,** by M. F. Dick, E. I. duPont de Nemours & Company, Waynesboro, Pa., and D. W. McCready, University of Michigan, Ann Arbor, Mich. 1953 ASME Annual Meeting paper No. **53—A-187** (mimeographed; available to Oct. 1, 1954; to be published in Trans. ASME).

A HORIZONTAL parallel plate apparatus was designed and constructed for the measurement of thermal conductivities of liquids. The liquid was held as a thin circular disk while the heat flux was downward through the liquid disk. The thickness of the liquid can be varied so the effect of thickness can be studied. The precision of the instrument is such that the results are within 1 per cent of the mean value.

The thermal conductivities of 19 liquid organic compounds were determined at 20 and 60 C. The compounds included isomeric ethers of varying structure, some esters of varying structure, and a hydrocarbon.




**Thermal-conductivity apparatus**

All theoretical equations and empirical correlations for the prediction of the thermal conductivities of liquids were tested using the thermal conductivities of the 19 liquids. None of the theoretical equations were able to predict satisfactorily the values of the thermal conductivities determined in this research. One empirical equation was found to reproduce the observed results well enough for engineering use.

The only available physical characteristic which would correlate the experimental results was the ASTM viscosity slope, and compounds containing rings did not correlate in this case. The experimental results were found to correlate best with the number of atoms in the longest chain. Corrections can be made for the effects of side chains and rings.

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**The Thermal Conductivity of Fluids,** by A. F. Schmidt, NBS Cryogenic Engineering Laboratory, and B. H. Spurlock, Jr., Mem. ASME, University of Colorado, Boulder, Colo. 1953 ASME Annual Meeting paper No. **53—A-184** (mimeographed; available to Oct. 1, 1954; to be published in Trans. ASME).

IN THIS paper an apparatus is developed which is capable of measuring the thermal conductivity of gases, vapors, and liquids over a wide range of temperatures. A compensating-type hot-wire apparatus was employed to make absolute thermal conductivity determinations of various fluids. In particular, air was used to check the agreement of experimental results between previous investigations and the present one. In addition, the thermal conductivities of furfural vapor and liquid were measured in order to supplement existing data in

the field of heat conduction with results of considerable industrial importance.

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**Convective Heat Transfer for Mixed-Free and Forced Flow Through Tubes,** by E. R. G. Eckert, Mem. ASME, University of Minnesota, Minneapolis, Minn., and A. J. Diaguila, Lewis Flight Propulsion Laboratory, National Advisory Committee for Aeronautics, Cleveland, Ohio. 1953 ASME Annual Meeting paper No. 53—A-191 (mimeographed; available to Oct. 1, 1954; to be published in Trans. ASME).

This paper presents current knowledge on heat transfer caused by simultaneously occurring free and forced convection in tubes.

It discusses the results of experiments that have been conducted by the NACA on mixed-free and forced-convection heat transfer in turbulent flow through a vertical tube with a length-to-diameter ratio of 5. In these studies, forced air flow was directed parallel or opposite to the flow direction which free-convection flow alone would have under the same temperature conditions. The Grashof number was varied in the range between $10^9$ and $10^{12}$ and the Reynolds number between $36 \times 10^3$ and $377 \times 10^3$. The experiments established, in the Reynolds-Grashof number field, the regimes in which heat transfer can be considered as caused by forced flow only, or by free convection only, or by the joint effect of free and forced convection. They determined also the magnitude of heat transfer in the different regimes.

Results of experiments made by other investigators, when analyzed in the same way as the NACA experiments, make it possible to generalize and extend the foregoing heat-transfer relations. A calculation by R. C. Martinelli and L. M. K. Boelter for laminar, mixed-free and forced flow in parallel direction, and its extension to flow in opposite direction, furnish information on heat transfer in the laminar-flow range.

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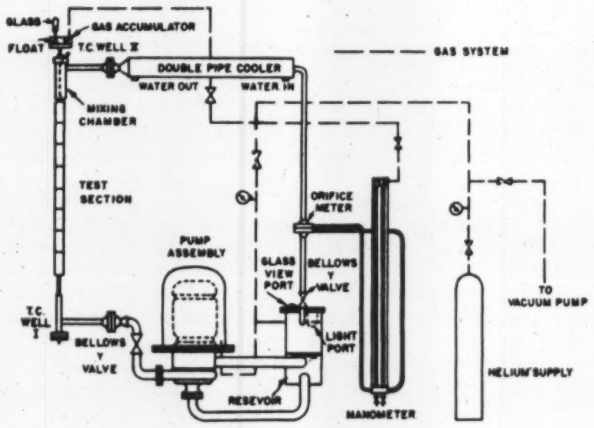
**Heat Transfer to Mercury in Turbulent Pipe Flow,** by H. A. Johnson, Mem. ASME, W. J. Clabaugh, Assoc. Mem. ASME, and J. P. Hartnett, University of California, Berkeley, Calif. 1953 ASME Annual Meeting paper No. 53—A-189 (mimeographed; available to Oct. 1, 1954; to be published in Trans. ASME).

Experimental heat-transfer results are presented for turbulent flow of nonwetting mercury in a $^3/_4$-in. 18-gage mild-steel tube with constant heat flux. The identical test heat exchanger developed for a previously reported investigation of molten lead-bismuth eutectic was used. This present investigation also




Schematic diagram of mercury heat-transfer system

includes a series of short-duration tests for possible effects due to secondary flow; i.e., vertical upward versus downward heated flow, the use of argon as an alternate for a helium gas atmosphere, and the addition of magnesium-titanium amalgam as a wetting agent. Heat-transfer tests with water preceded and followed those for mercury to establish continuing reliable performance of the test exchanger and its instrumentation.

As a result of this investigation the following conclusions are presented:

1 The direction of flow, upward or downward, had no noticeable effect on the heat transfer.

2 The heat-transfer performance was not affected by changing the internal inert-gas atmosphere from helium to argon, although the thermal conductivities differ by a ratio of 9 to 1.

3 The addition of a wetting agent of magnesium and titanium did not influence the heat-transfer performance in this investigation, nor was there visual evidence that any wetting of the exchanger surface had occurred.

4 When compared on the basis of the Nusselt versus Peclet modulus correlation, the bulk of mercury heat-transfer data for this investigation are 4 to 10 per cent lower than the lead-bismuth results obtained in the identical test-section heat exchanger.

5 There are indications that a distinction may exist between thermal and visual wetting.

6 Within ±15 per cent, the results of the majority of investigations for nonwetting lead-bismuth and mercury are represented by a mean Nusselt versus Peclet line which is 38 per cent below the Lyon equation.

7 A thermal entry length of approximately 30 diam, increasing slightly with Reynolds modulus and apparently insensitive to the Prandtl number over the range tested, is indicated.

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**Heat Transfer to Lead-Bismuth and Mercury in Laminar and Transition Pipe Flow,** by H. A. Johnson, Mem. ASME, W. J. Clabaugh, Assoc. Mem. ASME, and J. P. Hartnett, University of California, Berkeley, Calif. 1953 ASME Annual Meeting paper No. 53—A-188 (mimeographed; available to Oct. 1, 1954; to be published in Trans. ASME).

Experimental heat-transfer results in the low Reynolds modulus range of 1000 to 10,000 are reported for two different liquid metals, lead-bismuth eutectic and mercury. The single heat exchanger used in both series of tests was a $^3/_4$-in., 18-gage, 4-ft-long mild-steel tube. Similar heat-transfer tests with water in laminar and turbulent flow were performed with this same tube before and after each liquid-metal series, and the agreement of the turbulent-water tests with previous published results supports the liquid-metals test procedure.

The data for both liquid metals, including flow in the upward and downward directions, are correlated on a Nusselt-Peclet basis with a single curve representing all experimental results with a maximum deviation of 20 per cent. The experimental Nusselt values decrease from approximately 6 at Reynolds number of 10,000 down to 1 at a Reynolds number of 1200 and are consequently considerably lower than the theoretical constant heat-rate laminar-flow Nusselt value of 4.36. Possible causes for this behavior which have been investigated and found to be inadequate when considered independently include: (*a*) Insulating gas layer or oxide-film fouling

at the heated surface; (*b*) nonwetting; (*c*) uncertainties in property values; (*d*) axial-conduction effects. Although no supporting data are available, a distortion of the velocity profile from the parabolic distribution appears to be the most plausible explanation.

**The Effect of Single-Roughness Elements on the Heat Transfer From a 1:3 Elliptical Cylinder,** by R. A. Seban, Mem. ASME, R. M. Drake, Jr., S. Levy, and D. L. Doughty, Assoc. Mem. ASME, University of California, Berkeley, Calif. 1953 ASME Annual Meeting paper No. **53—A-86** (mimeographed; available to Oct. 1, 1954; to be published in Trans. ASME).

THE effect of single-roughness elements on the heat transfer from the surface of a 1:3 elliptical cylinder to an air stream has been investigated by placing single spanwise nylon filaments on the surface of the cylinder. The results are compared with those for the smooth surface of the same cylinder which already have been presented, and as before, these results are given in terms of the pressure coefficient, recovery factor, and local heat-transfer coefficient. On-stream air speeds ranged from 184 to 423 fps giving Reynolds numbers, based on the 6-in. chord of the cylinder, from 531,000 to 1,200,000. The roughness element produced an effect in all cases, and in the majority there was an apparent transition to turbulent flow either at or downstream of the element. In those cases in which the roughness element was not too large compared to the thickness of the laminar boundary layer, the heat-transfer coefficients after the point of transition were in good accord with those predicted from the Colburn equation. The point of transition itself was in approximate agreement with values found by other experimenters.

**Heat Transfer in a Gas-Fired Furnace,** by S. J. Genna, Sloan-Kettering Cancer Research Institute, New York, N. Y., and E. J. Nolan and A. A. Furczyk, Selas Corporation of America, Philadelphia, Pa. 1953 ASME Annual Meeting paper No. **53—A-190** (mimeographed; available to Oct. 1, 1954; to be published in Trans. ASME).

THE general problem of heat transfer in a gas-fired furnace is examined. A method of analysis is introduced for determining the contributions of the various modes of heat transfer. A particular furnace, gas-fired with nonluminous flames, is investigated in the temperature range of 1750 F to 2110 F. The results indicate that approximately 80 per cent of the heat is transferred by radiation from the furnace walls to the charge being heated. The remainder of the heat is transferred by gas convection and gas radiation.

**A Review of Thermal Radiation Constants,** by N. W. Snyder, University of California, Berkeley, Calif. 1953 ASME Annual Meeting paper No. **53—A-176** (mimeographed; available to Oct. 1, 1954; to be published in Trans. ASME).

A SURVEY of engineering literature and some of the recent textbooks in heat transfer indicates a lack of knowledge by the authors that the various radiation constants used are no longer valid.

The various radiation constants, as reported in the CGS system of units by Birge, have been ignored, as well as the recent work of Dumond and Cohen who have further refined the constants reported by Birge. The one particular constant which seems to vary from reference to reference is the Stefan-Boltzmann constant, $\sigma$. Values appear to range from $1723 \times 10^{-12}$ Btu/hr ft$^2$°R$^4$ to $1740 \times 12^{-12}$. An investigation by the author of the atomic constants presented by Birge and Dumond and Cohen indicates that this constant should be $1714 \times 10^{-12}$.

A complete discussion concerning the various constants is given in the paper.

**Thermal Radiation Tables and Applications,** by R. V. Dunkle, University of California, Berkeley, Calif. 1953 ASME Annual Meeting paper No. **53—A-220** (mimeographed; available to Oct. 1, 1954; to be published in Trans. ASME).

IN THIS paper the properties of ideal thermal radiators have been tabulated in a generalized form for use with ideal sources at any temperature. These tables are presented in a form which simplifies the computation of total radiant properties from spectral properties for nonideal sources and receivers, and examples of their utilization are included. The values of the thermal radiation constants utilized in the preparation of the tables were the latest available. Conventional engineering units are employed in this paper, conversion to other systems of units being readily accomplished.

These tables were prepared from the tables computed by the Federal Works Agency, Work Projects Administration, after converting to engineering units and correcting for the revised values of the radiation constants.

**Kinetic Theory of Evaporation Rates of Liquids,** by E. F. Lype, Mem. ASME, Armour Research Foundation, Illinois Institute of Technology, Chicago, Ill. 1953 ASME Annual Meeting paper No. **53—A-134** (mimeographed; available to Oct. 1, 1954; to be published in Trans. ASME).

THE rate of evaporation of a liquid is calculated from the Polanyi-Wigner theory of the escape of molecules from the surface of a solid body. In particular, the rate of evaporation of a "pseudo-crystalline" fluid, such as water, is obtained from Volmer's extension of this theory to the case where the molecules escape only from isolated locations, creating holes in the surface. The rate of condensation on the surface of a "pseudo-crystalline" fluid is obtained by applying the kinetic theory of gases to the case where condensation occurs only in the holes created by this process of evaporation. The energy of escape is in conformity with the virial theorem as applied to the Lennard-Jones-Devonshire equation of state. Mass and heat transfer calculated from these laws for phases of unequal temperatures, when applied to the "pseudo-crystalline" substance, water, agree closely with Jakob's and Dergarabedian's experiments on boiling water.

**Heat Transfer and Fluid Friction During Flow Across the Banks of Tubes, V—A Study of a Cylindrical Baffled Exchanger Without Internal Leakage,** by O. P. Bergelin, G. A. Brown, and A. P. Colburn, Mem. ASME, University of Delaware, Newark, Del. 1953 ASME Annual Meeting paper No. **53—A-173** (mimeographed; available to Oct. 1, 1954; to be published in Trans. ASME).

THE experimental results of a research program on tubular heat exchangers have been extended from unbaffled rectangular tube banks to a cylindrical baffled exchanger designed so that internal leakage can be eliminated or accurately controlled. The present results represent the first stage, in which internal leakage is essentially absent, and future work will be directed to evaluate the effects of known leakage areas.

Pressure drops across a single cross-flow section and a single window are measured during viscous and turbulent flow for heating, cooling, and isothermal conditions. The exchanger is 5.25 in. ID and contains eighty $^3/_8$-in-diam tubes on a staggered square arrangement with a 1.25 pitch ratio. Baffle cut-downs of 18, 31, and 43 per cent of the shell diameter and baffle spacings from 0.5 to 3.7 in. are covered. The ratio of cross-flow area to window area varies from 0.225 to 1.64. The Reynolds number range is 2.5 to 14,000.

The friction results for the cross-flow

section agree well with previous data on simple cross-flow units in the turbulent region but are somewhat lower in the viscous region. The pressure loss in the baffle window is found to be part friction and part kinetic loss in turbulent flow, and practically all friction in viscous flow. The heat-transfer data are determined as average values of heat-transfer coefficients for the entire exchanger. A means is presented for estimating the rate in the baffle-window section which makes it possible to determine the results in the cross-flow section. The latter agree well with simple cross-flow data in the turbulent region, but, like the friction results, are somewhat low in the viscous region.

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**Tube Expanding and Related Subjects,** by Frank F. Fisher (retired), and George J. Brown, The Detroit Edison Company, Detroit, Mich. 1953 ASME Annual Meeting paper No. **53—A-174** (mimeographed; available to Oct. 1, 1954; to be published in Trans. ASME).

TUBE expanding, known also as tube rolling or "rolling-in" of tubes, is the art of cold-working the ends of tubes into intimate contact with the metal of the containing tube holes. Properly executed, this rolling-in process produces pressure-tight joints of great strength and stability. The value and fitness of this method of fastening tubes to sheets or headers is attested by the fact that most utility services, factory outputs, and many material processes depend upon equipment or apparatus having expanded tube joints. In fact, in many cases, tube rolling is the only practical method of fastening tubes to headers.

ASME Codes establish definite design standards for boilers and unfired pressure vessels but do not cover the making and rolling of joints. Thus this important matter is left to the judgment of individuals who may be inexperienced, and in consequence, joints that are well-designed may be rolled improperly and give unsatisfactory service. It is apparent, therefore, that in order to prevent costly service interruptions, expensive shutdowns, and repairs, the rolling-in of tubes should proceed in the best possible manner.

The paper summarizes experiences gained by the expanding of tubes into various types of powerhouse equipment and by the development of improved expanding tools and new rolling methods. Manual and controlled rolling methods are described and their relative merits discussed. Information is given relative to the making of rolled joints having optimum strength and stability. All subject matter is viewed and discussed from a practical standpoint and references are cited, if pertinent and available.

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**Local Boiling Heat Transfer to Water at Low Reynolds Numbers and High Pressures,** by J. A. Clark and W. M. Rohsenow, Assoc. Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1953 ASME Annual Meeting paper No. **53—A-183** (mimeographed; available to Oct. 1, 1954; to be published in Trans. ASME).

LOCAL surface coefficients of heat transfer and maximum heat-flux density are presented for degassed, distilled water flowing upward in a vertical L-nickel tube under the following conditions: Mass velocities in the range 2.6 to 73 lbm/ft² sec (or inlet velocities in the range 0.05 to 1.4 fps), absolute pressures up to 2000 psia, and liquid subcooling between 0 to 300 F. The effects of natural convection on the nonboiling heat-transfer process were found to be significant, causing the transition from laminar to turbulent flow at the surface to occur at length Reynolds number in the range 60,000-100,000. Emphasis is placed on data in the region of surface boiling. The test section dimensions were 0.180 in. ID and 9.4 in. long.

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**Electronic Control Method for the Precision Expanding of Tubes,** by Frank E. Dudley, Franklin Manufacturing Company, Inc., Westmont, N. J. 1953 ASME Annual Meeting paper No. **53—A-133** (mimeographed; available to Oct. 1, 1954; to be published in Trans. ASME).

AS CONDITIONS of temperature and pressure become more severe in modern heat-transfer equipment, the art of expanding tubes must keep abreast of this progress in engineering. This is especially true with tubes being expanded at both ends where metal-to-metal fixed joints are required to maintain absolute leak-tight integrity and mechanical stability for safe and efficient operation. Overexpanding imposes excessive cold-work stresses in tubes and sheets, resulting in early failures. Underexpanding carries its burden of leakage and added nonproductive hours for correction in the field. This paper relates to progress in the precision expanding of tubes during the past few years. It covers controlled rolling, tests of electronic-controlled expanding, tube-expanding techniques, expanding in double-sheet exchangers, and the expanded joint for mechanical assemblies.

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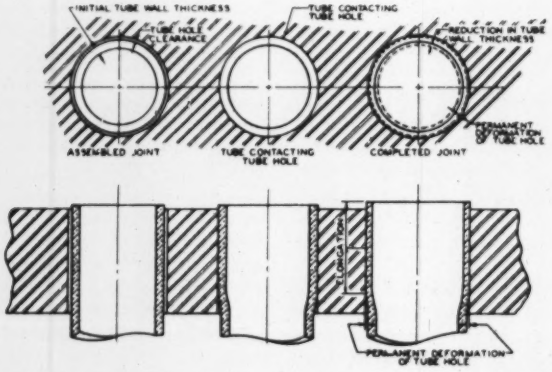
**The Viscosity, Thermal Conductivity, and Prandtl Number for Air, $O_2$, $N_2$, NO, $H_2$, CO, $CO_2$, HO, He, and A,** by Joseph Hilsenrath, National Bureau of Standards, Washington, D. C., and Y. S. Touloukian, Mem. ASME, Purdue University, Lafayette, Ind. 1953 ASME Annual Meeting paper No. **53—A-186** (mimeographed; available to Oct. 1, 1954; to be published in Trans. ASME).

AN INCREASING number of heat-transfer problems ranging from the design of heat exchangers to the aerodynamic heating of planes and missiles require, among other data, a precise knowledge of the transport properties, the heat capacity, and the Prandtl number of gases. A brief survey of the extent of the experimental viscosity and thermal conductivity data for 12 gases available in 1948 was given by G. A. Hawkins. Later F. G. Keyes published a more detailed review of these experimental data for nine gases, giving correlating equations and a theoretical discussion on the calculation of viscosities for nonpolar molecules from the characteristic Lennard-Jones parameters for the gas in the manner of Hirschfelder, Bird, and Spotz.




**Three stages of tube expanding. Joint shown is typical of feedwater heaters and similar equipment.**

This paper reports some of the results of a comprehensive compilation and correlation of thermal data—thermodynamic as well as transport properties—for gases undertaken at the National Bureau of Standards with the co-operation of the National Advisory Committee for Aeronautics.

The low-pressure viscosity and heat-transfer parameters—thermal conductivity and Prandtl number—are tabulated for air, nitrogen, oxygen, hydrogen, argon, carbon monoxide, carbon dioxide, nitric oxide, steam, and helium. The properties are tabulated for atmospheric pressure and extend from 100 K (180 R) to as high as 2000 K (3600 R) in some instances. The effect of pressure on the viscosity is presented in tabular form for oxygen, nitrogen, hydrogen, steam, carbon dioxide, and argon for pressures up to 100 atm in the experimental range of temperatures. The Prandtl numbers for air given in this work are compared with existing published and unpublished values which are in extensive use. Plots are included showing the scatter among the experimental data and deviations between them and the tabulated values. They present a clear picture of the extent and concordance of the experimental data. A monogram is included for obtaining fractional powers of the Prandtl number.

## Hydraulic Power

**Performance of the Periphery Pump,** by H. W. Iverson, Assoc. Mem. ASME, University of California, Berkeley, Calif. 1953 ASME Annual Meeting paper No. **53—A-102** (mimeographed; available to Oct. 1, 1954; to be published in Trans. ASME).

THE periphery pump, also designated as the tangential, turbine-vane, regenerative, turbulence, or friction pump, produces pumping action by the motion of a rough surface in a channel-containing fluid. The fluid is dragged along by the rough surface, and, with suitable restraints in the channel, the fluid head is increased in the direction of the flow.

Essential elements of the periphery pump are as follows: The impeller is a disk with vanes on the periphery. The casing contains the fluid passage, or raceway. Inlet and discharge ports connect the external-system piping to the raceway. Between the discharge and inlet, the casing clearance is reduced to block the high-pressure discharge from the low-pressure inlet. Clearances between the impeller disk and the casing are kept to a minimum to prevent leakage from the high-pressure side of the pump back to the low-pressure side.

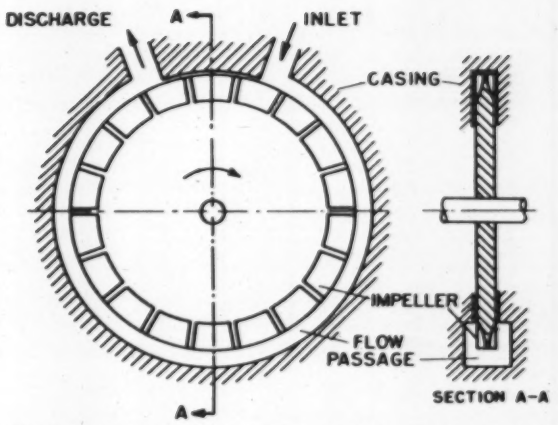



**Diagram showing essential elements of the periphery pump**

The periphery-pump performance is analyzed in terms of shear stresses imparted to the fluid by the impeller. The resulting expressions include two shear coefficients and an average impeller velocity which are determined experimentally. The analysis predicts the shapes of the performance curves of head, power, and efficiency as functions of the flow rate.

The shear coefficients, and hence the pump performance, are shown to be functions of the impeller roughness, and of the flow channel area.

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**The Kaplan Turbine, Discussion of Design and Trends,** by J. Fisch, Mem. ASME, S. Morgan Smith Company, York, Pa. 1953 ASME Annual Meeting paper No. **53—A-101** (mimeographed; available to Oct. 1, 1954; to be published in Trans. ASME).

THE adjustable-blade propeller turbine, known in the hydropower industry as a Kaplan turbine, in honor of its inventor, Dr. V. Kaplan of Brunn, Czechoslovakia, was first introduced in Europe in the early 1920's, and in the United States in 1928. Since then, approximately 274 units with a total output of 7,647,000 hp have been installed, or are under construction, in this country. Runner diameters vary from 30 to 292 in. and maximum operating heads for the individual units range from 7 to 105 ft. The world's most powerful Kaplan turbine is in operation at the U. S. Engineers' McNary Dam, developing a guaranteed output of 111,300 hp under a net head of 80 ft. This output will be surpassed by the Dalles units, also for the U. S. Engineers, which are rated at 123,000 hp under 81-ft head.

The main feature of the Kaplan turbine is the simultaneous adjustability of its runner blades and wicket gates which, when properly synchronized for varying conditions of load, results in a very flat efficiency curve, thereby improving part-load efficiency over other reaction-type turbines by a considerable amount.

Being essentially an infinite number of propeller runners with different blade angles built into one unit, the Kaplan turbine maintains high efficiency over a wide range of load.

Usually, the normal rating corresponding with the generator capacity occurs at a blade position less than maximum open and where the efficiency is still high. The ability to go to wide-open position during periods of high tail water results in large outputs during flood seasons when water is plentiful but capacity is limited due to reduction in head.

The high specific speed of Kaplan runners results in economy of the over-all installation due to higher-speed generators which, together with the adjustable features, readily justifies selection of Kaplan turbines for heads up to 100 ft. Its flexibility, greater over-all power output, and conservation of stored water at part load have resulted in wide application in the low and medium-head field.

The high unit capacity per inch of runner diameter effects substantial savings in dimensions and cost of the powerhouse structure and excavation.

Careful studies of the over-all power output in multiunit installations based on head and flow-duration data, usually result in worth-while gains if all units are of the Kaplan type rather than a combination of Kaplan and fixed-blade-propeller units. Cost comparisons must be based on the entire development rather than on the turbines alone to obtain realistic answers. Only relatively small yearly kwhr output gains are necessary

to pay for the increased investment in Kaplan units.

The trend today in Kaplan-turbine installations is primarily toward higher heads into the region where Francis turbines heretofore have been the only practicable choice. Also, the development continues of Kaplan runners for installations under lower heads than formerly have been economically feasible, aided by improved methods of earth and rock removal, which is required for the relatively low setting with regard to the elevation of the tail water.


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**Grand Coulee Model-Pump Investigation of Transient Pressures and Methods for Their Reduction,** by Ernest Lindros, Assoc. Mem. ASME, Byron-Jackson Co., Los Angeles, Calif. 1953 ASME Annual Meeting paper No. **53—A-213** (mimeographed; available to Oct. 1, 1954; to be published in Trans. ASME).

In May, 1951, when the first of six pumps ordered for the Grand Coulee Dam was put in service, a defect of major concern was discovered. This unfavorable condition embodied objectionable discharge-line vibration. Investigation revealed that this was caused by transient pressure variation in the pump, and remedial measures incorporating reinforcement of the discharge lines were taken to minimize this condition. However, no investigation was made of the offending transient pressure variation. This paper describes such an investigation, the test setup used, and reveals the difficulty encountered in applying instrumentation to obtain necessary data.

It is evident, from the tests concluded, that accurate quantitive measurements of transient pressures, comparable to those occurring in a prototype, cannot be observed in a model, unless suction and discharge lines also are modeled accurately and flow condition duplicated. Qualitative agreement may be obtained if reasonable care is used to avoid extraneous disturbances.

The paper points out that transient pressures encountered in this installation are, in a measure, a result of the abnormal pump design dictated by the operating conditions. These conditions include normal operation (over 80 per cent of total) at over capacity and lowest head with ample suction head, maximum efficiency at a higher head due to reduced suction head, and maximum head (135 per cent of the minimum) with a minimum suction head which determined suction design to avoid cavitation at a quite abnormal minimum flow. Obviously, this required a compromise design. Furthermore, the operating heads and size of these pumps excluded the use of single or double-volute design with the massive ribbing required, and made only the adopted fixed-vane-diffuser design economically feasible. All of the foregoing design requirements contributed to the strength of transient pressures produced.

This paper points out the reason that transient pressures, even though minor, were significant. The size of the unit, and consequent low operating speed of 200 rpm, resulted in transient pressure frequencies within the range of the natural frequencies of the thin-walled discharge line, particularly near its upper end. For these lines, it is not the strength, but the stiffness, that is important. The effect of vacuum, present in the uppermost sections of the discharge lines, contributes to the initiation of vibration. The strength of transient pressures decreases but little in the length of the line, but as the absolute pressure is very low, the fluctuations become of the same order.

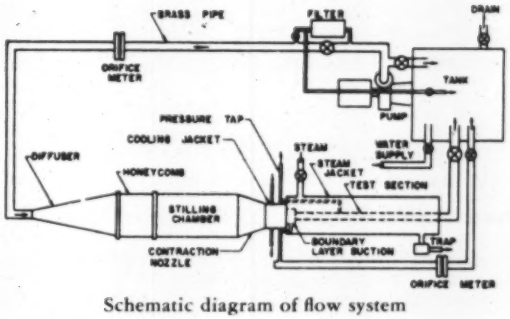
Even before any alterations were made, these fluctuations were only 9 per cent of the total pressure at the discharge nozzle, but resulted in accelerations of the ribed pipe line equivalent to 13.5 *g*. After more than 2 years of experimentation, the pressure transients were reduced to approximately 3.9 per cent of the total pressure at the pump discharge at minimum operating head. These transients, weakened only slightly by transmission through a little more than 800 ft of pipe and two elbows, result in discharge-pipe accelerations equivalent to about 3.5 *g*.

A further study of this problem is indicated, particularly for large pumps of low rpm (frequency) with large thin-walled discharge lines.

**The Effect of Heating on Boundary-Layer Transition for Liquid Flow in a Tube,** by R. Siegel and A. H. Shapiro, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1953 ASME Annual Meeting paper No. **53—A-178** (mimeographed; available to Oct. 1, 1954).

By analogy with the effects of heat transfer on laminar stability for gas flows, it is reasonable to anticipate that heating a water flow might increase the stability of the laminar boundary layer in a stream of vanishingly small disturbance level.

To investigate whether heating would in fact produce significant changes in the position of transition from a laminar to a turbulent layer in a stream having a very small but finite disturbance level, experiments were carried out in the entry region of a smooth tube where the boundary-layer thickness is small compared with the tube radius. The turbulence level of the stream was such as to




Schematic diagram of flow system

yield adiabatic length Reynolds numbers of transition as high as 850,000.

Heating was found to have no significant effect on the position of transition and generally led to an earlier location of transition. Although the desired effect of delaying transition might be observed with streams of even lower turbulence level, it may be concluded that in most practical situations it will not be possible to extend the zone of laminar flow by heating of liquid boundary layers.

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**The Analysis and Evaluation of Compressor Performance,** by M. C. Stuart, Fellow ASME, and T. E. Jackson, Mem. ASME, Lehigh University, Bethlehem, Pa. 1953 ASME Annual Meeting paper No. **53—A-53** (mimeographed; available to Oct. 1, 1954).

THE wide variety of compressor applications has given rise to a number of ways of expressing the merit of the performance of a compressor. This circumstance is illustrated by the names of some of the "efficiencies" which are currently employed to express compressor performance, e.g., adiabatic, isothermal, polytropic, hydraulic, internal, effective, and the like. This paper presents a method of analysis of compressor performance and proposes an approach to the selection of measures of performance which have significance in particular cases.

Data from a series of tests on a cooled and uncooled multistage centrifugal compressor are given. By using these data a comprehensive analysis of the energy transformation in both cooled and uncooled compressors has been made in an illustrative form; the first and second law energy analyses have been made for some idealized reversible processes between the same pressure range such as adiabatic reversible compression, polytropic reversible compression, adiabatic reversible air engine working over the temperature of the surroundings, isothermal reversible compression, and adiabatic reversible air engine working under the surrounding temperature. And, as a primary objective, a series of performance coefficients, or Figures of Merit, have been defined and computed by using the results of these idealized processes.

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**Visualization Studies of Secondary Flows With Applications to Turbomachines,** by Howard Z. Herzig and Arthur G. Hansen, Lewis Flight Propulsion Laboratory, National Advisory Committee for Aeronautics, Cleveland, Ohio. 1953 ASME Annual Meeting paper No. **53—A-56** (mimeographed; available to Oct. 1, 1954; to be published in Trans. ASME).

PRESENT-DAY blade design is based mainly on modified two-dimensional or quasi three-dimensional flow theories of perfect inviscid flows. The design is then refined by allowing for such factors as boundary-layer thickness and growth by use of formulas developed from classical studies of simple-flow configuration. Inherent in this procedure is the assumption that such corrections for the effects of viscosity can yield good approximations to the real fluid behavior in the actual turbomachines. Verification of this assumption theoretically can be accomplished only by comparison of the results with a solution for the complete viscous-flow equations in the turbomachine. At the present time, such complete solutions have not been obtained because of the mathematical complexitiy of the problem. Nevertheless, the combination of simplified flow theories with adjustments for boundary-layer effects has made it possible to achieve fairly satisfactory design procedures for turbomachines that operate at low and moderate flow speeds.

However, with the trend toward high-speed, high-mass-flow turbomachines, these boundary-layer effects become increasingly significant. As transonic velocities are approached, the boundary-layer accumulations and three-dimensional boundary-layer flows, together with their effects upon the main-stream flow, give rise to such large deviations from desired conditions in turbomachines, based on simplified-flow design methods, that the ordinary, rough qualitative adjustments are no longer adequate. With useful solutions of the complete flow equations still quite remote, it becomes important for the designer to be able to refine his qualitative adjustment procedures in order to compensate successfully for the increased boundary-layer deviations. This, in turn, requires more fundamental information concerning the boundary-layer flow patterns in turbomachines.

These considerations motivated a series of experimental investigations at the NACA Lewis laboratory. This paper presents and considers applications of the combined results of these investigations, which used flow-visualization techniques as well as total-pressure and flow-angle measurements in order to obtain an insight into the three-dimensional boundary-layer flow patterns in typical axial-flow turbomachines. The particular boundary-layer phenomena considered are: (*a*) Secondary flows in the shroud region (secondary flows are defined as any motions of boundary-layer fluid having components normal to the through-flow directions); (*b*) radial transport of boundary-layer material; and (*c*) blade-tip clearance-region secondary flows with and without relative motion between the blades and end walls or shrouds.

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**Noise Control in Industrial Areas—Principles and Practice,** by William A. Jack, Johns Manville Research Center, Manville, N. J. 1953 ASME Annual Meeting paper No. **53—A-55** (mimeographed; available to Oct. 1, 1954).

THE problem of noise control can be dealt with from several viewpoints. The viewpoint of most value to a given individual depends on his particular interest in the noise problem. The acoustical engineer is often requested to control the noise from a large machine without affecting its output, interfering with its operation, taking up much space, or spending a great deal of money. What can be done in the field of noise control depends on the nature of the noise source, the techniques and materials available for noise control, and the compromises possible in arriving at a workable solution. Possible methods of control include, for example, such diverse factors as redesign of a noisy machine, interposition of a sound barrier, acoustical treatment of a room, and the wearing of ear plugs by exposed personnel. This paper discusses the techniques for noise reduction used by the practicing acoustical engineer, who, in general, is asked to

control a noisy machine by methods not involving redesign.

Adequate commercial noise-control devices are available for insertion where required in compressor pipe lines at inlet and outlet. When air flows from the atmosphere to a compressor, it is interrupted by the necessary chopping action of the impeller. Pressure variations in the form of sound waves travel up the incoming air stream and enter the atmosphere, producing disturbing sounds in a variety of frequencies depending on the equipment and the piping. Silencers based on resonator or sound-absorbing principles, or combinations of these principles, when placed between the atmosphere and the compressor, provide noise control by reducing the pressure variations before they strike the atmosphere. On the downstream side a silencer performs in a similar way, sending on to the rest of the system an air flow with minimum sonic pressure variations. Silencer designs are available which have practically no adverse effect on the volumetric efficiency of the compressor system.

Properly designed sound traps placed in the piping system give useful noise control in the frequency range above 400 cps.

When mechanical equipment is rigidly bolted to a building structure, vibrations from the equipment enter the structure and may travel long distances. Although an executive's office may be some distance away so that air-borne sound is effectively barred by walls, the building vibration, which is not so barred, may generate noise in his office. Where it is possible to do so, the best solution is the mounting of the offending equipment on vibration isolators.

Good isolation is obtained when the compliance of the mount is such that the natural frequency of the equipment on its isolators is substantially lower than the lowest frequency against which isolation is desired.

When a sound source is properly enclosed, a substantial reduction in sound level is obtained in the rest of the space, provided that the source in question was the predominant cause of noise in the room.

The conventional use of sound-absorbing materials is against the structural surfaces of the room. It is possible to hang units at convenient locations throughout the volume of the room. This is a use of absorbing materials which is a rather radical departure from conventional practice, but appears to be of value in certain industrial applications. Such units are known variously as space, functional, suspended, or unit absorbers. They are useful in factory applications where overhead belting, piping, or ductwork make it impractical or impossible to install a conventional acoustical ceiling.

## Availability List of Unpublished ASME Papers

A NUMBER of papers and reports were presented at ASME Meetings which were not preprinted nor published. Manuscript copies of these papers are on file for reference purposes in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y. Photostatic copies of these unpublished papers may be secured from the Library at the rate of 40 cents per page; 35 cents per page to ASME members. The following papers recently have been placed on file in the Engineering Societies Library:

### 1953 ASME Petroleum Mechanical Engineering Conference

The Economics of Packaged Compressor Plants, by E. S. McRoberts

Control of Internal Corrosion of Tankers, by William B. Jupp and Carl J. Lamb

The ASME Pressure-Vessel Code, by Elmer O. Bergman

Factors Influencing the Performance of Internal Insulating Linings in Pressure Equipment, by J. J. Murphy and C. M. Vogrin

Utilization of Computers for Solutions of Pumping and Drilling-Equipment Problems, by Emory N. Kemler and Richard J. Howe

Monolithic-Type Linings for Refinery Service, by Walter A. Bradbury

Design of Hot-Tap Tee Connections in High-Pressure Pipe Lines, by A. J. Del Buono, P. L. Vissat, and Frank S. G. Williams

Scheduling Refinery Maintenance at Gulf Oil Corporation's Refinery, Port Arthur, Texas, by C. E. Gunter

Preventive Maintenance of Refinery Compressors, by J. R. Ware

Experience With Tri-Fuel Engines in Pipe-Line Service, by L. P. Meade and G. P. Jennings

The Use of Radioactive Isotopes in Pipe-Line Interface Marking, by J. Kohl and R. L. Newacheck

Application of Gas Turbines to Gas Transmission Lines, by S. R. Sawyer

Introductory Problems Encountered in the Use of Strain Gages, by Edwin D. Nuttal and Hale C. Goodrich

The Application of Reciprocating-Pump Valve Lifters to Closed-System Operation, by T. S. Llewellyn and M. T. Nigh

New Developments in Compressor-Equipment Design and Performance for Natural-Gas Transmission Pipe-Line Service, by B. T. Mast

Microwave Control of Pumping Stations, by R. C. Cheek

The Mechanical Aspects of "Hot Tapping," by B. VerNooy

Progress Report on a Fluid-Actuated Rotary-Percussion Engine, by W. H. Cline, Jr.

## ASME Transactions for February, 1954

THE February, 1954, issue of the Transactions of the ASME (available at $1 per copy to ASME members; $1.50 to nonmembers) contains the following:

TECHNICAL PAPERS

Valve-Gear Fundamentals for the Large-Engine Designer, by J. A. Newton and C. H. Allen. (53—OGP-2)

Discontinuous Chip Formation, by N. H. Cook, Iain Finnie, and M. C. Shaw.

Proposal for a Standard Design for General Industrial Coarse-Pitch Cylindrical Worm Gearing, by F. G. East. (53—S-5)

The Elastic-Fluid Centripetal Turbine for High Specific Outputs, by Rudolph Birmann. (53—S-16)

A Plastic-Flow Problem Arising in the Theory of Discontinuous Machining, by E. H. Lee. (53—S-22)

The Friction Terms in Metal Cutting, by W. C. Leone and Edward Saibel. (53—SA-16)

Predicting the Angle of Chip Flow for Single-Point Cutting Tools, by L. V. Colwell. (53—SA-17)

Dynamic Properties of Nodular Cast Iron, Part 2—Size Effect, by Harry Majors, Jr. (53—SA-25)

On the Analysis of Cutting-Tool Temperatures, by E. G. Loewen and M. C. Shaw. (53—S-15)

The Use of Stator-Blade Control to Obtain Wide Range of Compressor Performance for Wind-Tunnel Application, by A. W. McCoy and M. J. Brunner. (53—SA-35)

The Mitigation of Marine Fouling by Anaerobic Treatment, by H. T. Duplice and R. C. Alexander. (53—SA-18)

Reduction of Condensate-Line Corrosion, by Scott Jensen and E. R. Lang. (53—SA-15)

Smokeless Burning of Waste Process Gases, by R. D. Reed. (53—SA-29)

Prevention of Babbitt Blisters in Thrust-Bearing Pads, by R. A. Baudry, D. W. Gunther, and B. B. Winer. (53—SA-23)

Design of Steam Piping and Valves for 1100 F, by F. A. Ritchings and Sabin Crocker. (53—SA-37)

Heat Transfer to Constant-Property Laminar Boundary-Layer Wedge Flows With Stepwise and Arbitrary Wall-Temperature Variation, by Steve Scesa and Solomon Levy. (53—SA-47)

Intermittent Heating of Airfoils for Ice Protection, Utilizing Hot Air, by H. H. Hauger, Jr. (53—SA-42)

Remarks on Film Condensation With Turbulent Flow, by R. A. Seban. (53—SA-44)

A Summary of NACA Research on Heat Transfer and Friction for Air Flowing Through Tube With Large Temperature Difference, by Benjamin Pinkel. (53—SA-34)

The Dynamics and Lubrication of a Miniature Turbine Rotor on Porous Bushings, by George Sines. (53—SA-36)

On the Solution of the Reynolds, Equation for Slider-Bearing Lubrication—VII, by F. Osterle, A. Charnes, and E. Saibel. (53—SA-1)

The Work-Sampling Technique, by A. J. Rowe. (53—SA-55)

# Comments on Papers

**Including Letters From Readers on Miscellaneous Subjects**

## Large Aluminum Forgings

### Comment by M. A. Meleon[1]

The author has presented an excellent dissertation[2] on the various problems associated with the use of large aluminum forgings. From a structures standpoint, the author has raised some questions which bear re-emphasizing.

There is no doubt that large aluminum forgings present tremendous structural advantages; however, attendant with these advantages, there arise certain problems which must be considered carefully in their design. The material in the long transverse direction has moderately poor ductility and in the short transverse direction the ductility is extremely poor. In die forgings the material across the parting plane likewise has extremely poor ductility. Under certain types of loadings and geometrical configuration, this poor ductility can greatly influence load-carrying capacity. As the author points out, careful consideration must be given to the orientation of the load with respect to the grain direction.

Another point to be emphasized is that to obtain the maximum structural efficiency from large forgings, forging techniques must be developed which will eliminate the weight penalties that evolve from draft angles, webs greater in thickness than dictated by the loads, excessive fillet radii, and excessive tolerances. As the author indicates, individually some of these items appear quite innocuous, however when their effects are integrated over the whole forgings, a considerable weight penalty may ensue.

Another item which is of paramount importance to the structures engineer is the quality of the material in the forging. As the author indicates, the effect of forging size on quality is as yet an unknown quantity. However, as the sizes of forgings grow and their importance in the airframe structure increase, it becomes increasingly important to have adequate means of ascertaining the internal homogeneity of the material. Much progress has been made in sonic-inspection techniques and it is anticipated that the need for this type of quality control will increase in the future.

[1] Lockheed Aircraft Corporation, Burbank, Calif.

[2] "Design Considerations Associated With Large Aluminum Forgings," by C. W. Andrews, MECHANICAL ENGINEERING, vol. 75, October, 1953, pp. 777–784.

### Comment by G. W. Motherwell[3] and A. L. Rustay[4]

The paper is a well-considered summary of many of the things we do and do not know about forgings that will be made on the big presses. The large-press program is moving ahead rapidly; as a result, some of the statements in the paper require modification.

It has been our experience that the longitudinal tensile properties of large die forgings, similar to those sketched in this paper, generally meet the requirements established by AMS specifications. Undoubtedly, there is a thickness or cross section beyond which this is not true.

At the present time we are experiencing no die breakage. In the past this conceivably may have been a problem, but through a series of relatively minor changes in practice die breakage has been controlled effectively.

The idea of using forgings from the blocker die to produce parts if the finish die breaks would be a good one, but we rarely design our blocker dies so that finished parts can be machined from them. There would be far too much stock in some locations and not enough in others to fill the finish die properly. If the blocker were to be left heavy so that adequate finish would be available all over, all of the other preliminary dies might have to be resunk and a larger initial stock size might be needed; a last resort practice.

Die materials certainly need to be investigated more thoroughly and work has been in progress for some time in at least four plants. Large die-sinking machines have been installed and ample die-sinking capacity is available at present for large dies. In fact, we are looking for such work right now, otherwise the 50,000-ton press, scheduled for completion next year, may be idle.

[3] Vice-President in charge of manufacturing, Wyman-Gordon Company, Worcester, Mass. Mem. ASME.

[4] Director of Research, Wyman-Gordon Company.

Development work is proceeding on the evaluation of forging stock of a proper size to make forgings on the larger presses. Preliminary results look promising, but it is evident that much must be done to attain and maintain adequate quality levels.

The cost of large forgings should become less as the manufacturers become more skillful in all of the operations that are needed to make these parts, but the airframe designers certainly must make cost comparisons of structures, with and without large forgings, to see if the use of such forgings is justified.

Cost at point of assembly and weight saving, if any, might be evaluated on the basis of the following comparisons for a given application:

1 Cost and weight of conventional assembly consisting of small forgings and extrusions.

2 Cost and weight of a basic large forging with small extrusions and forgings to complete the structure.

3 Cost and weight of a single large forging designed to perform the same functions as items 1 and 2.

### Comment by A. H. Petersen[5]

This paper gives one of the clearest analyses of why large forgings are under consideration by the aircraft industry so far presented.

On a point-by-point basis the following comments are offered:

#### Strength

Thickness and cross-sectional area are critical from the standpoint of corrosion resistance since in the case of 75S alloy particularly, this will depend in great measure upon the speed of the quench, and the effect begins to be appreciable at about 2 in. thickness.

The properties indicated in Table 1 of the paper which are now guaranteed in sections not over 3 in. thick at the time of heat-treatment are obviously a result of the degree of work which was put into the billets. Certainly greater extruding pressures to refine the ingot prior to

[5] Lockheed Aircraft Corporation, Burbank, Calif.

forging and the additional work which can be imparted due to the increased pressures which will be available will improve properties in the larger sizes. Variation of properties dependent on direction should be reduced materially if proper attention is given to forging sequence.

In die forgings themselves, the lesser strengths will occur across the parting line; proper attention to blocker designs and location of the parting line have proved to increase these properties effectively. Since, obviously, the properties are in great measure the result of metal flow, poor blocker design results in excessive movement of metal in finishing dies normal to the parting line and excessive flashing. As a result, the properties will be poor.

We contend it is possible to predict properties in any given area before forging. The complexity of the design, the section thicknesses, and the degree of variation in thickness throughout the part will dictate the variation in properties from one area to another, but assuming that the forging can be produced, the question becomes one of how much will it cost to produce the properties desired.

The seven points made by the author in his discussion under strength could not be expressed better. Careful adherence to these few simple rules will serve to avoid most of the pitfalls we are worried about.

### Weight

Die-closure tolerances can be controlled accurately from one part to another on a press, although difficult to do on a hammer. Again, blocker design and the amount of metal which must be moved in the finishing operation have a great effect on this tolerance. Too often in the past, blockers have been held to a minimum and not enough attention paid to moving metal in them sufficiently so that the finishing die can achieve the required configuration without excessive metal movement and flashing, thus causing wide variations in tolerance.

Realizing that pressures are not the only solution to obtaining an accurate forging and if the large presses are not to deliver the same type of forgings we are receiving today, that is, those which must be machined all over, then to facilitate forging and limit costs, "in-processing" machining must be used by forging vendors prior to final finishing. Certainly it is uneconomical and also undesirable metallurgically to remove forged surfaces by machining. If pressures will not do it, the raised pad (Fig. 2 of paper) should be removed partially by machining to a point where only the minimum amount of material is left to be moved in the final finishing operation in order to obtain the optimum structure. The same thinking applies to the channel-type forging. These are only two examples of where such machining can be employed usefully. It has the effect of permitting the holding of closer tolerances, of achieving desired thicknesses, maintaining the desirable forged surfaces, of reducing excessive machining times in users' plants, and the very real problem of warpage which such final machining is causing today. We cannot have a school of thought on forging and another school on machining. These two tools of design must be used where of greatest advantage and not only in sequence, one after the other.

### Costs

The use of 75S should not place a 20 to 30 per cent cost penalty on the user. We know 14S is more forgable than 75S but the difference on very large components is not sufficient to require additional tooling for the latter. Generally, when higher forging temperatures are used on 75S, and this has been proved to be practicable, then the same processing techniques are applicable to both alloys. In fact, the much wider use of 75S should have the effect of reducing the costs rather than increasing them.

Figures in Table 3 of the paper definitely indicate the trend requiring increasing refinement in die-forging techniques regardless of the advent of increased pressures. Any technique serving to increase the cost of the finished forging must certainly decrease the total cost of the completed part. It is our experience that for the larger forging, the greatest cost is in the material which goes into it. However, to reduce cost, we consistently have advocated consideration of cast dies for small runs and experimental work. Forging producers are in the process of proving that they can get closer to finished-part configuration by using such dies at lower cost than by offering us the so-called blocker-type forging.

It is yet to be proved that segmental dies will be practical for large forgings but since their use will reduce downtime, provide for easier maintenance, and permit production of the die segments on lower cost machines, it behooves the forging producers to evaluate such dies, since an over-all reduction in cost will tend to promote the use of forgings in more applications.

In discussing costs, Figs. 9, 10, 11, and 12 of the paper illustrate conditions which, in our opinion, the forging producers still do not understand thoroughly. In each of the cases described, the forged product must be machined completely in order to arrive at a configuration of minimum weight. Today, within the Los Angeles area, there are innumerable jobbing shops operating day and night to produce designs such as these for the aircraft industry. This work has been farmed out to them simply because there are not enough machine tools of the proper type available within the industry itself and, since the design use was justified in each case, sources had to be found. Shops having duplicating milling machines charge anywhere from $15 to $25 an hour for time on these machines and when we consider the fixtures and setups involved for each run, the potential saving the producer can afford us is enormous.

### Availability

Limited sources for large forgings, in our experience, have not failed to keep Wyman-Gordon's and Alcoa's heavy presses busy. Aircraft companies using these presses have found it necessary to use them, and the thought of breakdown has not deterred them.

To be specific regarding die failures, these normally only occur as a result of errors of one type or another. Generally finish-die failures can be attributed to poor blocker design and insufficient metal movement prior to the finishing stage.

Large die blocks are not long-time procurement items for the types of designs we have seen over the past year. In no case have we seen a practicable forging design which required a block larger than 10 tons and the presently available sources, including one right in the Southern California area, can produce such blocks within a very short space of time.

It does not necessarily follow that every forging produced on the large presses will fill the press bed completely. AMC estimates were based on a raw-forging weight of 165 lb but our personal studies of many dozens of forging designs indicate that this figure is more than double the actual weights to be expected. Refinements, accuracy, and better properties apply equally to smaller forgings which always will constitute the bulk of the work.

In regard to availability of machine tools, we refer to our previous statements regarding "in-process" machining and the fact that finish machining should be applicable to attaching surfaces and bores only. Certainly, specialized equipment is needed but in terms of higher speeds

and feeds than the conventional cast-iron milling equipment can give us. Some progress is being made in this direction but a unified-industry approach to put pressure in the proper quarters will be invaluable in solving this problem.

### Quality

Outside of the reduction of properties resulting from ineffective working of large sections to the center or core we raise the question of why it should be anticipated that increased forging size will have an adverse effect on quality. Personally, we deplore the use of the term "unhealed porosity" since it implies that there is such a thing as "healed porosity." Certainly a poor ingot is no place to begin the production of a quality forging. We are confident that forging quality should improve on the mere premise that there is too much time and money sunk in these forgings to permit the use of faulty or sloppy practices.

We would suggest that it is not the stresses induced by the forging process which cause warpage but quenching stresses out of heat-treat. The forging stresses generally are relieved by the heat-treatment, but aging temperatures are so low that they afford little relief and the quenching stresses remain in the material. We repeat our caution that removing compressive surface layers by machining may contribute to stress corrosion, that corrosion-fatigue failures are similar to stress corrosion, and that it is the tensile-stress part of the cycle of fluctuating stress which causes breakdown of structures. We must have forging designs and forging practices that will reduce the possibility of this type of failure. As an immediate solution the writer's company has been more successful in fully machining prior to solution heat treatment and then straightening in the SW or "as-quenched" condition rather than rough machining, heat-treating, and then finish machining because in the latter, the quenching stresses are still present and the lightest of machine cuts may still remove them, or at least cause enough relief to create warpage.

### Conclusion

We like the author's conclusion that the specific design influences the answer. Certainly the trend is not to simplification of forging design but rather to more complexities, but in our work on many different types of design with men having actual experience in the forging field we feel that we have a right to be very optimistic. We urge that a unified front be presented inpressing for greater improvements and refinements in the state of the art. Certainly our designers are not limiting aircraft performance with preconceived opinions of how far they can go. They are never reluctant to test a new configuration of aircraft with higher performance requirements than previously tried. The same applies to each individual part of the aircraft and the advancement must be concurrent. If we all follow the author's advice and his thinking, we are going to get the results that we want.

## Comment by Richard S. Reinhold[6]

This paper covers the subject of large aluminum forgings in a comprehensive and accurate manner. As the author says there are more unknowns than knowns. This, then, gives one an open opportunity to discuss the subject with impunity.

The potential advantages to accrue from the use of large forgings are great indeed. The extent of these advantages will not be known fully until the new heavy presses that are scheduled to come into operation next year are in use for some time. Unfortunately, some unforeseen problems undoubtedly will arise. Fortunately, however, few problems are without solutions.

### Advantages

Among the advantages in addition to those mentioned by the author is the increase in fatigue strength to be realized from a single homogeneous structure by virtue of eliminating fittings and their attendant fasteners, holes, and other stress raisers. This is in addition to the increased fatigue life gained by the more advantageous grain direction available in forgings in general.

Weight penalties arising from tolerances on the thicknesses of webs might well be minimized by use of open truss-type forgings. If fuel or vapor tightness is required it might be achieved by means of a thin light-metal web attached to the forging by structural adhesives. The weight of this web, in many cases, would be less than even the tolerance on a large flat forged web. In this connection, however, it would be well to point out that large forged trusses are particularly sensitive to straightness tolerances on the compression members.

It is felt in many quarters that the most important advantages are to be gained from the use of the new large presses in forging parts with greater precision than formerly has been possible. The author mentions the machining economies to be realized by eliminating some or most of the postforging machining operations. This might be at the expense of size in forgings since reduced tolerances will require higher unit pressures on the part being forged.

### Disadvantages

Among the disadvantages expected in large forgings are increased tolerances due to thermal expansion in the dies. This problem, has, of course, been with us all along; however, as forgings increase in sizes up to 20 to 30 ft in length extremely close die-temperature control will become imperative to produce forgings that are usable at all. This temperature control will be necessary not only in a single die but also between dies to prevent excessive mismatch.

Another point that demands close attention is that of design change. The availability, usefulness, and economy of large forgings would be impaired seriously by the slightest change in design requiring reworking or scrapping of large and extremely expensive dies. This, of course, would prevent a designer from considering a part as a large forging if it appears subject to future changes of more than a very minor degree.

In view of these factors it appears to many that greater usefulness of the large heavy forging presses, at least for sometime, will lie in their ability to exert very high unit pressures, thus producing forgings of greater precision rather than forgings of great size.

### Author's Closure

Referring to comments by Messrs. Motherwell and Rustay, the author agrees that only in very rare cases will the blocker-stage forging make acceptable parts for finish use. In one case the author's company was able to maintain production on a critical fitting by using blocker-stage forgings when a finish-stage die failed.

Mr. Petersen suggests that "it is not the stresses induced by the forging process which cause warpage, but quenching stresses out of heat-treat." The author admits an unfortunate choice of words and agrees that quenching is the real culprit.

The author agrees with Mr. Reinhold that an over-all improvement in fatigue strength will result from a single homogeneous structure and it is an advantage worthy of pointed emphasis.

C. W. Andrews.[7]

[6] Structural Development Engineer, Boeing Airplane Company, Seattle, Wash.

[7] Assistant Chief of Structures, Douglas Aircraft Company, Inc., Long Beach, Calif.

## Blind Flying

The caption under the Doolittle photograph,[8] perpetuates an historical misconception which, I see, is also the topic of some advertisement in the United States.

Without in the least detracting from General Doolittle's pioneering in blind flight, the fact is that there was a school of blind flying operated by Farman at Toussus-le-Noble, Paris, France, where every pupil made blind flights with a safety pilot, as a matter of routine. Radio was not fitted so that landings were not made. But at the RAF, Farnborough, England, blind landings were being made by the aid of a so-called "ground proximeter."

General Doolittle's flight was with a safety pilot; the first "solo" blind flight was, I believe, made on April 17, 1931, at the Central Flying School, RAF (England) and again without radio and, therefore, without landing. Many flights before that with a safety pilot had been made, complete with landing after a "talk-down" by the safety pilot who confined himself to radio-like instructions.

I possess a film showing a solo blind take-off, climb, aerobatics, spin and recovery, which routine became a standard RAF demonstration in 1931. The only real risk was that of collision, but since only one aircraft was allowed to perform this excercise at a time, the odds were not too bad.

Patrick Johnson.[9]

## Joint Authorship

### Comment by W. N. Findley[10]

This is indeed an often neglected problem[11] which, however, has been of considerable concern to the writer upon a number of occasions. The writer finds himself in nearly 100 per cent agreement with the point of view which the authors have expressed so ably.

The establishment of principles upon which to base decisions is of the first importance, but as is well known, the application of these principles to specific situations is often even more difficult than evolving the principles.

The writer believes that on a number of occasions he has departed from the principles outlined in the paper to include as authors, junior assistants who have contributed substantially to neither the ideas nor writing of the paper but who have contributed unusually diligent, faithful service and interest in their assigned projects. Whether this is a good practice may be a question.

On the other hand, there are instances in which research assistants have contributed to the ideas or to the writing but their performances have been so lacking in responsibility and accuracy that there remained a question as to whether authorship had been earned.

Also, there are instances in which research personnel of high promise but limited experience contribute both the major ideas and writing but their efforts must be continually checked by the project supervisor and revised. Thus the project supervisor must expend considerable effort in training these personnel and must bear the responsibility for the quality and accuracy of the research. Perhaps under these circumstances he should be one of the authors.

#### Proportioning credit

The authors point out the prevalance of multiauthored papers and the tendency to refer to these in the form "Jones, et al." This practice tends, it seems, to give the first author more than the intended credit. To avoid this, in reporting currently an extensive research project to which several people contributed the writer is proposing to prepare two or more papers on portions of the project and limit the number of authors to not more than three on any one paper. In this scheme an individual would receive authorship according to his contribution to the total effort, not necessarily in proportion to his contribution to a given paper. For example, suppose A, B, C, D, and E have earned authorship. Following the proposed scheme three papers might be authored as follows: (1) A B C, (2) A D B, (3) C A E, yet E may have contributed in a small way to both (1) and (2) as well as (3).

Other questions arise in reporting scientific investigations: Is there any less reason for including as an author one whose skillful construction of apparatus or testing or computations made the work of good quality than one who did a skillful job of writing but did not contribute the ideas?

It may be that the scientist who contributed the ideas involved was not proficient in or was disinterested in the application of either of these skills. In other words, the writer is suggesting that technical report writing may be a skill rather than a creative activity. In the writer's opinion the creative activity connected with a technical report is in the working out of the original ideas, not in the writing. On the other hand, in composing poetry the creative activity is in the writing itself.

If the contribution of ideas was considered to be the major criterion for authorship, which might be one interpretation of the last comments, who should author technical papers (of which there are a few) that contain no ideas—only observations?

#### Authors' Closure

The authors are grateful to Mr. Findley for his comments and for his presentation of several interesting questions and cases. What people do is strongly influenced by what they regard as "proper." Our purpose in writing the article was to call attention to the need for some sort of loose agreement or general feeling among engineers and scientists as to what constitutes desirable practice in deciding on authorship. The best one could hope for is that certain guiding principles might become accepted by an appreciable proportion of those concerned.

In suggesting certain authorship criteria, we were, of course, starting the discussion by expressing our own ideas. We hope, if sufficient people give the problem some thought, that eventually a prevailing opinion of what is proper will become a strong influence on authorship selection, just as it is now in the matter of technical-writing style.

If and when conventional principles as to authorship become widely known and understood, there will still be many special deviations owing to particular circumstances. As Mr. Findley says, the actual decision, even though guided by accepted principles, would sometimes be a difficult matter.

Since no accepted general principles now exist, we can discuss Mr. Findley's points only in the light of what was suggested in our article. In our opinion, the inclusion as an author of a junior assistant who has merely performed work which was largely arranged for him, however faithful and interested he may have been, is not good practice. We feel that the reward for diligence should take other forms (his important contribution can be fully acknowledged in the paper, for example) but that an authorship designation in this instance is a false labeling of his part in the work.

#### Earned Authorship

Whether authorship is earned by a contribution which is thoroughly irrespon-

[8] "ASME Role in Powered Flight," by H. F. Reeve, MECHANICAL ENGINEERING, vol. 75, December, 1953, p. 993.

[9] London, England.

[10] Research Associate Professor of Theoretical and Applied Mechanics, College of Engineering, University of Illinois, Urbana, Ill.

[11] "When Should a Paper Have Joint Authorship?" by Walton Forstall, Jr., and W. F. Stokey, MECHANICAL ENGINEERING, vol. 75, November, 1953, pp. 875–876.

sible and filled with inaccuracies is a matter which must be decided in any particular instance by someone with proper administrative authority. A performance so discreditable that the net result is harm rather than help to joint scientific effort probably would not be considered qualification for authorship.

Regarding the next point, if a project supervisor must expend considerable effort in assuring the quality and accuracy of the research and if the paper in its final form is good because somehow or other he, personally, made it so, it would seem reasonable for him to appear as an author.

Reference to multiauthored papers by the first author's name may tend to give undue credit to the first author. In reducing the number of authors, however, the application of stricter standards in determining what constitutes "substantial contribution" is probably the direction in which to move rather than an attempt to reward all participants by at least one authorship in a series of papers.

Mr. Findley raises the question as to whether in some cases writing should not be considered a technician's skill, similar to that of the shop mechanic. In the extreme instance where the person who writes the article contributes only a technical-writing ability, a case can be made for omitting his name as an author. When we used the words "to be listed as an author one should have contributed substantially to the ideas around which the paper is written, or have written an appreciable portion of the paper, or both," we had in mind the more usual case where the writer of the paper does perform at least an interpretive function, which is one requiring both a scientific understanding of what was done and an ability to present it clearly and with proper emphasis.

In a paper which contains no new idea, but which is nevertheless, for some reason, worth publishing, it seems proper that the writer should appear as the author. After all, the purpose of listing authors is to give credit for what has been done, and in such a case there is no possibility of misinterpretation, as long as the author has given suitable credit to his sources.

W. Forstall, Jr.[12]
W. F. Stokey.[13]

[12] Associate Professor, Department of Mechanical Engineering, Carnegie Institute of Technology. Mem. ASME.

[13] Assistant Professor, Department of Mechanical Engineering, Carnegie Institute of Technology. Assoc. Mem. ASME.

## Pumps for Liquid Metals

### Comment by P. J. Moroz[14]

THE author is to be congratulated on his timely, interesting, and well-written paper on the subject of pumps for high-temperature liquid metal.[15]

The real success of all fluid-handling equipment depends to a great extent upon the excellence and durability of the sealing mechanism. Mechanical seals are being used more and more today for the more difficult services. The author's account of the problems encountered in arriving at the best combination of materials for the mechanical seal faces is typical of similar programs for other difficult-to-seal services.

It may be of interest to the author and others to relate some of our experiences along these lines:

1 Extreme flatness of seal faces is necessary if low leakage rates are to be attained.

2 Flatnesses of less than one light band can be obtained from commercial lapping machines provided the room is air conditioned and constant temperature is maintained.

3 Good surface finish is obtained concurrently with flatness and needs no further check. It would be of interest to know the author's method in determining surface finish as the tracer type probably would scratch the surface too badly and make relapping necessary.

4 Erratic wear of carbon-seal faces was traced to incomplete impregnation with a resin or other material. This could result either from incomplete initial penetration or from subsequent removal by machining, as depth is limited and, no doubt, is variable. Graphitar No. 39 was one such material. It is realized that the author's seals may have been improved considerably since his paper, but control of this detail may improve reliability to the extent that the 100-hour test can be eliminated.

5 It is assumed that the author's tests were all run at the same peripheral speed. If not, we would like to know the basis for extrapolation.

[14] Mechanical Consultant, Construction Division, E. I. du Pont de Nemours & Company, Inc., Savannah River Plant, Augusta, Ga. Assoc. Mem. ASME.

[15] "Mechanical Pumps for High-Temperature Liquid Metals," by P. M. Clark, MECHANICAL ENGINEERING, vol. 75, August, 1953, pp. 615–618

### Author's Closure

In order to answer questions and confirm Mr. Moroz' statements, the following points are presented:

1 Accurate lapping can be accomplished by the use of commercial lapping machines as suggested. Hand lapping was developed here because no lapping machines were readily available.

However only the seal wear rings are manufactured in our plant. The seals are received from the vendor already finished.

2 The seal wear rings normally are made of very hard material so that the profilometer tracer does not cause severe damage. To eliminate the need for relapping, the measurements are taken on an area where no contact is encountered with the carbon-seal face. Surface finish on the face of the carbon is determined by visual inspection only. Test data did not show a significant difference in operation between seals due to carbon surface finish except, perhaps, during the initial or "run-in" part of the test.

3 Erratic test results may well be due to the type and extent of carbon impregnation as the writer suggests.

4 Extrapolation is based on the amount of measured wear in relation to the initial projection height of the carbon.

The same peripheral speed was used for all but a few of the very first tests. A question as to acceptable limits of lubrication and the best method of applying lubrication provoked an additional variable for several of the test runs. The problem here is the danger of contamination in the liquid-metal system.

The success of mechanical seals is dependent upon the quality and durability of the materials used, the compatability of the materials, and the accuracy and care taken with the manufacture of all components. Adequate safeguards must be taken to protect the present commercial seals using carbon-seal faces from corrosion, entrance of foreign materials, and excessive temperature. The story does not end here, however, because future developments can be expected to give us improved materials capable of operating at higher temperatures in corrosive atmospheres. As these improvements are made the mechanical seal will find wider use for increasingly difficult tasks.

P. M. Clark.[16]

[16] Engineering Development Section, Knolls Atomic Power Labroatory, Schenectady, N. Y.

# *Reviews of Books*

## And Notes on Books Received in Engineering Societies Library

## Instrument Engineering

INSTRUMENT ENGINEERING, Vol. 2. By Charles Stark Draper, Walter McKay, and Sidney Lees. McGraw-Hill Book Co., Inc., McGraw-Hill Publications in Aeronautical Science, New York, N. Y.; Toronto Ont., Can.; London, England, 1953. $8^3/_4 \times 11^1/_4$ in., figs., tables, bibliography, index, xxviii and 827 pp., $15.

### Reviewed by Rufus Oldenburger[1]

The first volume by the authors on the subject of instrument engineering appeared in 1952. This volume was devoted to reducing instrument problems to mathematical equivalents and to the discussion of the mathematical topics of statistics, series representations of functions, and the frequency-response approach. Since the appearance of the first volume, the second has been awaited with much interest by those concerned with the teaching and practice of measurement and automatic control. They will not be disappointed. Volume 2, printed by the offset process, is a comprehensive treatment of various mathematical techniques essential to the intelligent solution of the integrodifferential equations associated with instrument problems.

### Mathematical Analysis

The book opens with a discussion of the differential equations that normally arise in the analysis of instruments and the systems on which measurements are made. Various methods of solution are given including the highly efficient and rapid one of synthetic division. Laplace transforms, weighting and transfer functions, pulse, step, and impulse disturbances, Nyquist's stability criterion, the root-locus method, and "numerical analysis" are treated in detail. The latter is concerned with the approximation to a function by triangular, rectangular, step, and ramp series. The authors emphasize that the instrument analyst should know as many mathematical techniques as possible so that he can treat each problem by methods suited to the problem. They are to be congratulated for this emphasis.

The book is written essentially in outline form. Each paragraph is numbered for ready reference, and running summaries are carried continuously throughout the entire volume, blocked out from the rest of the text. This makes it particularly easy for the reader to review the theory of the book although it breaks up the text somewhat disconcertingly. In an effort to make the information in equations as self-contained as possible the authors use the complicated symbolism of volume 1. Thus where others would write $f(t_k)$ in an equation, defining this function elsewhere, the authors employ [*IFRS*] $f('t_k)$, meaning the "impulse function representation strength" $f('t_k)$, where the prime denotes that time is nondimensionalized. The conventional "L" for "Laplace transform of" is replaced by the more cumbersome "[*LT*]." This effort to include in the formulas as much as possible is not without precedent. Eliakim Hastings Moore, dean of American mathematicians in his day, introduced a complicated symbolism to his field of "General Analysis" in an effort to make each mathematical statement more precise and self-contained. Although his co-workers employed his notations while he was living, his students (the writer was one of them) referred to his approach as "General Paralysis," and after his death the symbolism was almost entirely dropped. The fact that mathematical activity in the fields of tensor analysis and relativity is and has been extremely limited is due in large part to the inherently complicated symbolism required to represent tensors. Although their objectives are laudable, and with practice one can become quite accustomed to their symbolism, it is to be hoped that the authors, in the projected volume 3, will revert to more standard usage.

### Treatment of Impulses

The treatment of impulses is conventional in that the authors use the concept of "Dirac function." This so-called "function," employed by P. A. M. Dirac in his work on quantum mechanics, has disturbed mathematicians since its introduction. In 1950 Laurent Schwartz[2] placed the Dirac function and associated concepts on a rigorous basis. For this he was awarded a prize at the International Mathematical Congress held at Harvard University in 1950. Undoubtedly, the work of Schwartz was too recent to be included in volume 2 and will find its place in the literature after industry has had enough experience with it.

The authors recommend a procedure for handling the equations of instrument problems. One step is the reduction of equations to nondimensional form. Although this is desirable for general theoretical studies, and the publication of results, it is the writer's experience that this is not so in the usual instrument-analysis situation where one is interested in the quickest practical solution of a specific problem.

Although their definition of "gain margin" does not coincide with the standard use of this expression,[3] this is not a serious handicap.

### Useful to Researchers

The criticisms mentioned are minor ones. The theory of volume 2 applies not only to instruments but equally well to servomechanisms, regulators, and communication. The book should be in the library of every engineer and scientist concerned with research and development in these domains. The theory of volume 2, which until now has been scattered throughout the literature,

[1] Director of Research, Woodward Governor Company, Rockford, Ill. Mem. ASME.

[2] Laurent Schwartz, Théorie des distributions, Hermann & Cie., Paris, France, 1950.

[3] Rufus Oldenburger, Frequency-Response Data Presentation Standards and Design Criteria, Paper No. 53—A-11, Frequency Response Symposium volume, ASME, 1953.

### *Library Services*

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any items in its collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

has been ably collected and presented here by outstanding authorities in the field.

This volume is a superb reference work for the man in industry, as well as an exposition for the student beginning his studies of the subject. The theory is illustrated by numerous well-chosen examples. The book will no doubt leave its impression on the field of cybernetics and accelerate the age of automatic control.

## Books Received in Library...

ATOMISATION OF LIQUID FUELS. By E. Giffen and A. Muraszew. John Wiley & Sons, Inc., New York, N. Y., 1953. 246 p., 8¾ × 5¾ in., bound. $6. This book, based on a survey of published information, is an attempt to picture the whole process by which an initially continuous liquid jet is broken up into a great number of small droplets—a process widely used with liquid fuels for internal-combustion engines and furnaces. It deals with the process of disintegration; characteristics of fuel sprays, and the effect on these of the atomizer, the liquid, the gaseous medium and injection pressure; the theory of the swirl atomizer; and experimental study methods.

DAS BLECH UND SEINE PRUFUNG. By Gerhard Oehler. Springer-Verlag, Berlin, Germany, 1953. 297 p., 9¼ × 6 ½ in., bound. 25.50 DM. A comprehensive treatment of the working and testing of steel and nonferrous sheet metal. Intended for works managers, plant engineers, and foremen, the book has five main divisions: sheet and strip for pressworking and drawing; workability of various sheet metals, sheet-metal thicknesses; strength testing; other tests—chemical, surface finish, metallographic, etc.

CAMBRIDGE ELEMENTARY STATISTICAL TABLES. By D. V. Lindley and J. C. P. Miller. Cambridge University Press, New York, N. Y., 1953. 35 p., 11 × 8½ in., paper. $1. A set of ten tables of the commoner statistical functions and tests of significance for users of statistical methods in scientific research, technology, and industry. Tables included are for the normal distribution and frequency functions, percentage points of various derivations of the normal distribution, the correlation coefficient and other common transformations, and random sampling numbers.

DAVISON'S TEXTILE BLUE BOOK. 88th year, July, 1953, edition. Davison Publishing Company, Ridgewood, N. J., 1953. 1549 p., 8⅛ × 5 in., bound. $6.50. A complete and comprehensive annual directory of the textile industry in the United States and Canada. New mills and firms, testing laboratories, textile schools, associations, manufacturers, and dealers have been added since last edition. Thumb-indexed in addition to complete alphabetical and geographical indexes to mills, dyers, and raw-cotton firms. The book is available either with or without the "buyers' guide" for machinery and equipment.

DISCONTINUOUS AUTOMATIC CONTROL. By Irmgard Flügge-Lotz. Princeton University Press, Princeton, N. J., 1953. 168 p., 9½ × 6½ in., bound. $5. Mechanical systems which have restoring forces, other than that of the control device, form the subject of this monograph. Their motions under the influence of discontinuous controls are studied in detail. The methods and results are not restricted to mechanical systems but apply also to thermodynamic and electrical systems whenever the differential equations are of the same form.

DYNAMICS AND THERMODYNAMICS OF COMPRESSIBLE FLUID FLOW, Volume 1. By Ascher H. Shapiro. Ronald Press Company, New York, N. Y., 1953. 647 p., 9¼ × 6¼ in., bound. $16. A comprehensive treatment of a subject of interest to aeronautical, mechanical, and chemical engineers, and applied physicists. Emphasizing practical aspects throughout, the book presents the subject matter under the following major section headings: background fundamentals; one-dimensional flow; introduction to flow in two and three dimensions; subsonic flow; supersonic flow. An outline of the mathematical theory underlying the method of characteristics is appended.

ENGINEERING LAW. By R. E. Laidlaw and C. R. Young. University of Toronto Press, Toronto, Canada, fourth edition, 1951. 394 p., 9¼ × 6¼ in., bound. $5.25. A simple presentation of those phases of Canadian law that relate to engineering, using a minimum of technical legal terms and avoiding subtle legal distinctions and conflicts. It covers contracts and specifications, arbitration, expert evidence, compensation, patents and inventions, and a wide range of engineering activities. Extracts from reports of typical cases have been added for illustration in the new edition.

FIFTY YEARS OF PAINT TESTING. (Special Technical Publication, No. 147.) American Society for Testing Materials, Philadelphia, Pa., 1953. 47 p., 9 × 6 in., paper. $1.25. A series of reports presented in 1952 which summarize the results of ASTM activities in the field. Major group headings include the following: drying oils, volatile hydrocarbon solvents, accelerated tests, chemical analysis of paint materials, varnish and shellac, pigment specifications, physical and optical properties of materials, protection of iron and steel.

HIGHER TRANSCENDAL FUNCTIONS, Volume 2. Compiled by the Bateman Manuscript Project at the California Institute of Technology. McGraw-Hill Book Company, Inc., New York, N. Y., 1953. 396 p., 9¼ × 6 ¼ in., bound. $7.50. This second volume of a comprehensive three-volume reference work for engineers, physicists, and mathematicians covers the following: Bessel and related functions, error functions; exponential, sine, and cosine integrals and related functions; parabolic cylinder functions; orthogonal polynomials; elliptic functions and integrals. These extensive and detailed treatments have been developed by four outstanding mathematical analysts.

HYDROCARBONS FROM PETROLEUM. (American Chemical Society, Monograph No. 121.) By Frederick D. Rossini, Beveridge J. Mair, and Anton J. Streiff. Reinhold Publishing Corporation, New York, N. Y., 1953. 556 p., 9¼ × 6 ¼ in., bound. $18.50. This book summarizes in convenient form the results of over twenty-five years of research on hydrocarbons by the American Petroleum Institute. Among the many aspects of the subject covered are principles of fractionating processes; apparatus for various methods of fractionating; procedures and apparatus for measuring physical properties; a summary of present knowledge of the composition of petroleum; and the analysis of certain refined petroleum products. Frequent reference is made throughout the study to the basic work of others.

INSTRUMENT ENGINEERING. Volume 2: Methods for Associating Mathematical Solutions With Common Forms. By Charles Stark Draper, Walter McKay, and Sidney Lees. McGraw-Hill Book Company, Inc., New York, N. Y., first edition, 1953. 827 p., 11 ¼ × 8¾ in., bound. $15. Continuing the presentation of a generalized method of attack on the problems of measurement and control, this second volume reviews the mathematical background and illustrates procedures by actual derivation of quantitative results. The subject content has been chosen to meet the needs of the working engineer who wishes to use any of various established methods of analysis. This comprehensive work is to be completed by a third volume giving practical problems and examples.

INTRODUCTION TO DYNAMICS. By L. A. Pars. Cambridge University Press, New York, N. Y., 1953. 501 p., 8¾ × 5 ¾ in., bound. $6. The scope of this book is defined as the study of motion in two dimensions—particle, rigid body, system—without Lagrange's equations. The material is arranged, from a discussion of scalar and vector quantities up through the motion and momentum of systems, to provide a logical and natural development of the subject. A number of special aspects are covered as well as the basic general theories.

NUCLEAR PHYSICS. By W. Heisenberg. Philosophical Library, New York, N. Y., 1953. 224 p., 7½ × 5 in., bound. $4.75. This is a book for those who have no training in theoretical physics but who are acquainted with physical ideas. An historical introduction is followed by chapters on the structures of molecules and atoms, radioactivity, atomic nuclei, nuclear forces and reactions, and instruments and procedures of the nuclear physicist. There is a final chapter on applications.

MECHANICAL VIBRATIONS. By William Tyrrell Thomson. Prentice-Hall, Inc., New York, N. Y., second edition, 1953. 252 p., 8¾ × 6 in., bound. $6. Intended for a first course in the subject this text presents the fundamentals of vibration theory and provides a general background for advanced study in the field. The last two chapters deal with the vibration of elastic bodies and with electromechanical systems and analogies. Numerous problems are presented throughout to illustrate the method of analysis.

METALLURGICAL DICTIONARY. By J. G. Henderson and J. M. Bates. Reinhold Publishing Corporation, New York, N. Y., 1953. 396 p., 9¼ × 6¼ in., bound. $8.50. An up-to-date, semiencyclopedic reference book containing some 5000 definitions and descriptions selectively limited to practical, current material. Arranged in simple alphabetical form and thoroughly cross-indexed, it includes in its scope definitions of terms in both production and physical metallurgy and related fields. Original definitions are given of many terms which have only recently appeared in magazine literature.

OIL IN THE SOVIET UNION. By Heinrich Hassman. Translated by Alfred M. Leeston. Princeton University Press, Princeton, N. J., 1953. 173 p., 9 ¾ × 6 ½ in., bound. $3.75. The Russian oil industry is discussed against a background of world economics and politics. The author follows its development from the beginning, describes the important producing and refining regions, and provides maps, footnotes, production figures, and other statistics.

The book is a translation from the original German edition.

PAST EXAMINATIONS FOR PROFESSIONAL ENGINEER—NEW YORK STATE. Compiled by John D. Constance, 625 Hudson Terrace, Cliffside Park, N. J., 1953 edition. 11 × 8½ in., paper. $1.50. This compilation of problems from past Professional Engineers' License Examinations in New York State now covers the period from January, 1943, through June, 1953. It includes the complete set of Parts 1, 2, and 3 in all cases.

PRESTRESSED CONCRETE. By Y. Guyon. Edited by W. M. Johns. John Wiley and Sons, Inc., New York, N. Y., 1953. 543 p., 9¾ × 6¼ in., bound. $12. This is a free translation of Guyon's comprehensive treatise on prestressed concrete, covering fundamental concepts, basic methods of construction, materials, analysis and calculations of prestressed units with different types of reinforcements and under various conditions, methods of investigating cracks and failures, and determination of safety factors. To broaden the book's value, worked examples and some test results have been recast using British dimensions.

PROTECTIVE ATMOSPHERES. By A. G. Hotchkiss and H. M. Webber. John Wiley and Sons, Inc., New York, N. Y., 1953. 341 p., 9¼ × 6 in. bound. $7. The practical aspects of the subject are emphasized with the intent of providing an operating manual for process engineers and metallurgists. The first chapter gives a tabulated summary of data on compositions and costs of typical protective gases, processes for which they are used, and recommended gases for particular applications. Succeeding chapters develop the subject, with separate chapters on types of atmospheres, instruments, storage and handling, applications, and practical remedies for operating difficulties.

RESEARCH OPERATIONS IN INDUSTRY. Papers delivered at Third Annual Conference of Industrial Research, June, 1952. Edited by David B. Hertz. King's Crown Press, Columbia University, New York, N. Y., 1953. 452 p., 8 ¾ × 5 ¾ in., bound. $8.50. Some thirty papers are broadly classified as follows: philosophy of industtial research; economics, costs, and budgeting; personnel in industrial research; planning of research programs; planning of facilities; methodology and design of experiment; operations research; communications and technical information services. Although mostly from the 1952 conference, a few selected papers from previous ones have been included to integrate the work.

SIMULTANEOUS LINEAR EQUATIONS AND THE DETERMINATION OF EIGENVALUES. (Applied Mathematics Series, No. 29.) National Bureau of Standards. Available from Superintendent of Documents, G.P.O., Washington 25, D. C., 1953. 126 p., 10 ½ × 8 in., bound. $1.50. Detailed explanations of various mathematical procedures for the solution of systems of linear equations and the determination of eigenvalues, together with a tentative classification of methods and an extensive general bibliography. A brief specialized list of references accompanies each particular procedure.

SPENDING FOR INDUSTRIAL RESEARCH, 1951–1952. By De Witt C. Dearborn, Rose W. Kneznek, and Robert N. Anthony. Harvard University, Graduate School of Business Administration, Boston, Mass., 1953. 103 p., 11 × 8 ½ in., paper. $2.50. Summarized quantitative information is given including scale of expenditures for research and development by industrial firms and variations of such expenditures among firms by industry and size. There are many tables analyzing total cost of research, broken down into cost per research worker, cost of research, classifications by types and size of industry, and research financed by Federal Government.

TECHNISCHE DYNAMIK. Volume 1, Grundlagen und Einzelne Maschinenteile; volume 2, Dampfturbinen und Brennkraftmaschinen. By C. B. Biezeno and R. Grammel. Springer-Verlag, Berlin, Germany, second edition, 1953. 699 p., 452 p., 10 × 7 in., bound. DM 66, DM 44. The two volumes of this comprehensive text on engineering dynamics cover, respectively: basic principles and individual machine elements; steam turbines and internal-combustion engines. A subject index covering both volumes is included in each. The new edition has been revised, with numerous additions.

TEMPERATURE MEASUREMENT IN ENGINEERING. VOLUME 1. By H. Dean Baker, E. A. Ryder, and N. H. Baker. John Wiley and Sons, Inc., New York, N. Y., 1953. 179 p., 9¼ × 6¼ in., bound. $3.75. This first volume of a two-volume work is primarily concerned with thermocouple techniques and includes introductory chapters on fundamentals, basic information necessary for the design of temperature-measuring apparatus, and specific designs for measuring internal temperatures and temperature gradients in solid bodies. The emphasis is on specific procedures and techniques for various circumstances, classified on a physical basis rather than by industry or type of instrumentation.

TRANE AIR CONDITIONING MANUAL. Trane Company, LaCrosse, Wis., revised, 1953. 380 p., 11¼ × 9 in., bound $5. Primarily concerned with the application of engineering fundamentals to the design of air-conditioning systems, this book covers the following major topics: heat and its transmission; physical comfort; air properties and supply; psychrometry; refrigeration and ventilation processes; ducts and fans; and the functions of water in air conditioning. A 70-page section of reference tables increases its practical value.

YEAR BOOK OF THE HEATING AND VENTILATING INDUSTRY, 1953. Issued in collaboration with the Association of Heating, Ventilating and Domestic Engineering Employers. Technitrade Journals, Ltd., London, W.C.1, England, 1953. 298 p., 8½ × 5½ in., bound. 7s.6d. An annual compilation of reference data, containing a bibliography of heating and ventilating literature for the preceding year, a list of pertinent British standards and codes, a list of British heating and ventilating engineering firms, trade names, and a buyers' guide. A few articles on technical or trade topics appear in each volume.

# ASME BOILER CODE

## Interpretations

THE Boiler Code Committee meets monthly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those which are approved are sent to the inquirers and are published in MECHANICAL ENGINEERING.

(The following Case Interpretations were formulated at the Committee meeting December 11, 1953, and approved by the Board on February 4, 1954.)

CASE NO. 1180

*(Special Ruling)*

*Inquiry:* The 1952 Edition of Section VIII, Table UCS-23, lists stress values for carbon-steel bar stock material furnished in accordance with Specification SA-306. May bar stock complying with Specification SA-7 be used in the construction of unfired pressure vessels?

*Reply:* It is the opinion of the Committee that, pending the time when bar stock complying with Specification SA-306 becomes generally available, it is permissible to use bar stock furnished in accordance with Specification SA-7 in the construction of unfired pressure vessels under Section VIII of the Code, provided that:

(1) The steel is manufactured by the electric-furnace or the open-hearth process.

(2) The design temperature at which the material is used is between —20 and 650 F.

(3) The stress value used in design is 12,650 psi.

(4) The procedure classification for this material in Table Q-11.1 in Section IX of Welding Qualifications is P No. 1.

CASE NO. 1170-1

(REOPENED)

*(Special Ruling)*

In the *Inquiry*, revise the first line of the tabulation to read:

0.095 in. for tubes 1¼ in. O.D. and smaller

## Cases Annulled

The following Cases are to be annulled:

| Case No. | Reason for Annulment |
|---|---|
| 1091 | Covered by Specification SB-247 and revised footnote 5, Table UNF-23, 1952 Section VIII |
| 1133 | Covered by Table UNF-23, 1952 Section VIII |

## Proposed Revisions and Addenda to Boiler and Pressure Vessel Code

As NEED arises, the Boiler Code Committee entertains suggestions for revising its Codes. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code.

Comments should be addressed to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.

### Unfired Pressure Vessels, 1952

PAR. U-1(d)(2) Revise to read:

(2) Vessels for containing water under pressure for domestic supply including those containing air, the compression of which serves only as a cushion.

Renumber present (3) and (4) as (4) and (5), respectively.

Add as a new (3):

(3) A domestic hot-water supply storage tank heated by steam or any other indirect means when none of the following limitations is exceeded:

(a) a heat input of 100,000 Btu per hour,
(b) a water temperature of 200 F,
(c) a nominal water-containing capacity of 120 gallons;

PAR. UG-36(c)(3)(a) Change "3 in. pipe size in vessel walls $^3/_8$ in. or less" to "3 in. pipe size in vessel shells or heads $^3/_8$ in. or less;" and change "2 in. pipe size in vessel walls over $^3/_8$ in." to "2 in. pipe size in vessel shells or heads over $^3/_8$ in."

PAR. UG-37(a) Revise to read:

(a) *General* The rules in this paragraph apply to all openings other than small openings covered by Par. UG-36(c)(3), large head openings covered by Par. UG-36(b)(2), and openings in flat heads covered by Par. UG-39.

PAR. UG-37(b) In the last line of (1), change "M = 1 to E = 1 and M = 1"; in the second line of (2), insert "seamless" before "cone"; in the seventh line of (3), insert "seamless" before "sphere."

PAR. UG-38 Revise to read:

UG-38 *Flued Openings in Formed Heads*

(a) Flued openings in formed heads made by inward or outward forming of the head plate shall meet the requirements for reinforcement in Par. UG-37.

(b) The minimum depth of flange of a flued opening exceeding 6 in. in any inside dimension, when not stayed by an attached pipe or flue, shall equal $3t$ or $(t + 3)$ in., whichever is less, where $t$ is the required head thickness. The depth of flange shall be determined by placing a straightedge across the side opposite the flued opening along the major axis and measuring from the straightedge to the edge of the flanged opening.

(c) The minimum width of bearing surface for a gasket on a self-sealing flued opening shall be in accordance with Par. UG-46(j).

PAR. UG-39 Reletter subparagraphs (a), (b), and (c) as (b), (c), and (d), respectively, and add a new subparagraph reading:

(a) *General* The rules in this paragraph apply to all openings other than small openings covered by Par. UG-36(c)(3).

PAR. UG-41(b) In the first and second lines, change "Par. UG-40(c)" to "Par. UG-40(a)."

PAR. UG-41(c) Add the following sentence: "For obround openings, consideration shall also be given to the strength of the attachment joint on one side of the plane transverse to the parallel sides of the opening which passes through the center of the semicircular end of the opening."

PAR. UG-44 Change "ASA B16e-1939" to "ASA B16.5-1953" in two places. Change "MSS 150 and 300 lb Bronze Flange and Flanged Fittings Standard, MSS SP-2-1946 (R-1949)" to "ASA B16.24-1953 Brass or Bronze Flanges and Flanged Fittings 150 and 300 lb." Change "MSS SP-42-1951" to "MSS SP-42-1953."

PAR. UG-45(2) Add the reference "(See Par. UG-31(c)(3).)"

PAR. UW-11(b) Revise to read:

(b) Butt welds joining the flange or saddle of an inserted type nozzle as shown in Fig. UW-16.1(q)(1) and (q)(2) shall be radiographed when the vessel or vessel section to which the nozzle is attached is required to be radiographed. Nozzles attached by fillet or corner welds, or both, need not be radiographed.

FIG. UW-11 Delete.

PAR. UW-14 Reletter present (b) and (c) as (c) and (d), respectively.

In present (c) (new (d)), change last line of reference from "(a)(2)" to "(b)."

Replace present (a) with the following (a) and (b):

(a) Any type of opening that meets the requirements for reinforcement given in Par. UG-37 may be located in a welded joint.

(b) Openings within the limits given in Par. UG-36(c)(3) that do not fully meet the requirements for reinforcement in Par. UG-37 may be located in head-to-shell and other circumferential joints, provided the weld meets the radiographic requirements in Par. UW-51(m) for a length equal to three times the diameter of the opening with the center of the hole at midlength. Defects that are completely removed in cutting the hole shall not be considered in judging the acceptability of the weld.

TABLE UCS-23 Revise footnote (1) to read: "(1) See Par. UCS-6(b)."

TABLE UCS-23 and TABLE UHA-23 Add the following as footnote to Table UCS-23 and as footnote to Table UHA-23: "All stress values in shear are 0.80 times the values in the above table. All stress values in bearing are 1.60 times the values in the above table."

TABLE UNF-23 Revise footnote (5) to read:

(5) The stress values given for this material are not applicable when either welding or thermal cutting are employed.

For Copper-Silicon A, C, D, SB-96 Plates & Sheet, under "Subzero to 150" change "10,000" to "12,000."

PAR. UA-280 In Example 1 insert the words "ring-type joint" between the words "pound" and "welding neck." In the first line on page 149, change "400 F" to "150 F."

TABLE UA-450 Change the parenthetical note in the heading from "(Table from ASA B16e-1939)" to "(Table from ASA B16.5-1953)."

TABLE UA-451 Change footnote 5 from ". . . as given in ASA B36.10-1935, Schedule 40" to ". . . as given in ASA B36.10-1950, Schedule 40."

Change footnote 6 from ". . . of the ASA B16e-1939" to ". . . of the ASA B16.5-1953."

TABLE UA-452 Replace with Tables 2 through 15, inclusive, from ASA B16.5-1953.

### Welding Qualifications, 1952

TABLE Q-11.1 Delete SA-203, Grade D and Grade F from Table P-5 and insert in Table P-9; change the designation "Grade F" to "Grade E."

### Announcement

The 1954 *Suggested Rules for Care of Power Boilers* will be published shortly and will be available from the ASME Order Department.

# *ASME NEWS*

**With Notes on the Engineering Profession**

# Professional Divisions Executives Conference Reviews Proposed ASME Policy Changes

## General Electric Company Host to Conference in Schenectady, N. Y.

THE ASME's proposed policy to improve the quality of meetings, conferences, and publications, and the proposed reorganization of the Council were subjected to an intense review during the first Professional Divisions Executives Conference, held January 7 and 8, at the Knolls Research Laboratory of the General Electric Company, Schenectady, N. Y. Sponsored by the Professional Divisions Committee, and headed by T. F. Perkinson, Mem. ASME and chairman of the committee, manager of G-E commercial transportation sales, the aim of the conference was to indoctrinate incoming Division executive committee chairmen and to discuss the purpose, operation, and general results to be obtained through Professional Division activities. Other subjects discussed at the conference included ASME Research, Section-Division Co-Operation, and Present Division Structure and Activities.

### President L. K. Sillcox Speaks

In addition, postwar progress in transportation was reviewed by ASME President Lewis K. Sillcox, at a dinner on Thursday evening in the Mohawk Golf Club. R. Cutts of the General Electric Company presided.

### Knolls Meeting Site

The Knolls Research Laboratory, at which G.E. played host to ASME, is situated on a commanding knoll overlooking the Mohawk River in the town of Niskayuna, near Schenectady. This imposing structure for research indeed served as a pleasant and appropriate meeting place for the 55 conference attendees, who delved into many of the Society's and the Divisions' operational problems in the interest of the entire membership.

Each of the ASME Divisions was represented either by the chairman or an official representative of the Division, as was the entire 1954 Professional Divisions Committee. The following committees and boards were also represented: Organization Committee, Board on Technology, Board on Codes and Standards, Meetings Committee, Publications Committee, and the Research Committee.

### G. E. Facilities Inspected

To relieve discussion, scheduled inspection tours were held Thursday afternoon—the first through the Knolls Research Laboratory, the second through the large steam-turbine generator and gas-turbine manufacturing facilities at the Schenectady plant of G.E.

### Improvement of Meetings and Publications

Of immediate concern to the entire ASME membership is the proposed improvement of meetings and publications scheme. The increase in the number of sessions at ASME National Meetings, especially the Annual Meeting, and a resulting increase in the number of papers recommended for publication in Transactions, coupled with a desire to tender the best service to members, led to the following Board on Technology's recommendations:

1 The Meetings Committee, shall, 12 months in advance, for each meeting, select a general theme, designate the number of sessions, and

**Colin Carmichael, Publications Committee: The proposed independent review of papers for publication will not eliminate continued review by Divisions and Committees of their own papers. Their opinions and guidance will always be of inestimable value in arriving at a final decision as to ultimate form of publication.**

**R. C. Allen, chairman, Research Committee: A strong and vital program of research is an important and necessary phase of ASME. The Society's research program affords further opportunities in the direction and analysis of advanced engineering developments, in addition to the physical accomplishments in the laboratory.**

**F. S. Mallette, ASME Research Manager: Research projects planned include the new program on the thermal properties of steam; further study of air pollution; a possible extension in the direction of nuclear-power developments. A study of "Human Engineering," or the relation of man to the machine, is also being contemplated.**

**I. K. Sillcox, President ASME, speaking at the dinner on Thursday evening, on postwar progress in transportation, says that we are in the midst of a revolution in transportation, namely, the amalgamation of the highways with the railways**

require each participating Division and Committee to specify a general subject and a chairman for each technical session.

2 The Professional Divisions Committee shall require each Division to hold an Annual Conference under its own sponsorship or in collaboration with other Divisions.

3 The Publications Committee shall conduct an independent review of papers recommended for publication and select those that are to be printed in Transactions.

Most of the discussion at the conference centered about Item 2, requiring Divisions to hold annual conferences. Arguments against holding such conferences brought out the facts that some Divisions are too small to sponsor an individual conference and that sometimes it isn't feasible for a Division to hold a conference. It was therefore suggested that the wording of Item 2 be changed from "shall require each Division to hold an Annual Conference" . . . to "it shall urge each Division to hold an Annual Conference" . . . . In other words, it was pointed out, the mandatory implication of the statement should be revised, thereby placing responsibility in the Division.

In arguments for the entire program, it was pointed out that the new procedures and new policies will effect smooth operation of the Division and will greatly improve the quality of the meetings and the papers presented at them, and more responsibility will be placed on the Division.

## Council Reorganization

In discussing Council Reorganization it was pointed out that at the Los Angeles meeting on June 28–29, 1953, the Council discussed at length the problem of securing leaders in Professional Divisions' work as Directors of the Society and requested the Organization Committee to submit at the 1953 Annual Meeting proposals for procedures which will permit the selection of directors from other than leaders in Section and Region activities.

## Organization Committee Report

Late in November the Committee prepared a report to the Council which was presented informally to the Administrative Conference of Professional Divisions on the evening of Nov. 29, 1953, and to the Council on Nov. 30, 1953. (See MECHANICAL ENGINEERING, January, 1954, pp. 73–76, p. 80, and p. 126.)

**C. W. Good, past-chairman, Professional Divisions Committee: Many Divisions recognize the possibility of co-operation with Sections. One Division has proposed including one representative from each of the eight Regions as associate members on its executive committee. Some Divisions are scheduling conferences with Sections.**

**C. E. Davies, Secretary ASME: The Divisions are responsible for the technical life of ASME. They provide ASME with a useful and thorough record for its publications. The Sections' responsibility is to a group of members within a definite territory—program-making and determining the members' interests to be served.**

**T. F. Perkinson, chairman, Professional Divisions Committee: Bigness requires a more adequate Division structure which a proposed specialized-interest survey may reveal. Questions now arising include: What is a Division? Who belongs? How is membership determined? Is registration in a Division, as currently practiced, adequate?**

**V. Weaver Smith, chairman, ASME Organization Committee: The proposed Council reorganization and the increase of members on the Nominating Committee from 8 to 11 will make it easier for Divisions to get representation on Council.**

**E. W. Jacobson, member, Professional Divisions Committee: Responsibility for a Division Conference should be shared equally by both the Division and Section. Conference site should be selected where most interested people are concentrated.**

**P. R. Sidler, member, Professional Divisions Committee: Not every Division can support an individual conference, particularly the smaller Divisions. Cooperation with other Divisions of the Society or interested bodies might be the solution.**

### Selection of Directors

The Organization Committee recommended that the eight Directors be selected from leaders of, and considered as representatives of, activities as follows:

1 Four Activity Directors, serving four years, one selected each fourth year in order from the following activities into which the Professional Divisions and Research Committees might be grouped: (*A*) Basic Sciences, (*B*) Power Production, (*C*) Management and Production, and (*D*) Industrial Applications.
2 Two Standardization Directors, serving four years, one to be selected every other year from those with experience and a record of leadership in ASME Standards and Codes work.
3 Two Directors at Large, serving four years, one to be selected every other year from those who have displayed leadership in the administrative work of the Society. Such Committees as Finance, Organization, and Constitution and By-Laws; and the Boards on Honors, Membership, Education, and Public Affairs are excellent training grounds for service on the Council.

The Organization Committee reached the conclusion that in order properly to bring about the desired changes, the Nominating Committee must be increased from eight to eleven, with alternates, the three additional to be selected as follows: one by the Board on Technology, one by the Board on Codes and Standards, and one by the Council.

After considerable discussion the Meeting endorsed the plan in principle [the ASME Council, at the 1953 Annual Meeting, discussed the report of the Organization Committee, made certain suggestions, requested deletion of the provision that one of the three additional members of the Nominating Committee be selected by the Council, and asked the Committee to submit revised recommendations by May 1, 1954. See MECHANICAL ENGINEERING, January, 1954, p. 126. *Editor*].

### Other Subjects Discussed

The subjects of ASME Research, Section-Division Co-Operation, Present Division Structure, and Division Activities aroused great interest and discussion—too lengthy to review in this brief report. However, while no specific actions were taken by the group, new ideas, numerous suggestions, and recommendations were made. For example, it was suggested that an over-all picture of the ASME Research program during the year be given at the Annual Meeting, either in the form of a luncheon address or at an open meeting of the Research Committee.

How to run a successful Division Conference was covered thoroughly; the Petroleum Division has a detailed manual on this subject.

Another important project, it was revealed, is the specialized-interest survey to be conducted by ASME. The survey, it is expected, will give ASME a more accurate appraisal of the specific technical interests of the membership. The existing Divisional setup, it was explained, does not give an accurate picture of true membership interest—it isn't up to date, because changes in interest are not reported.

### Next Meeting—Pittsburgh, Pa.

Because of the success of this first conference it was decided that a similar meeting be held in January, 1955, in Pittsburgh, Pa., with Gulf Research and Development Company as host.

**ASME Membership as of Jan. 31, 1954**

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| Honorary Members | 52 |
| Fellows | 385 |
| Members | 14,014 |
| Affiliates | 335 |
| Associate Members (33 and over) | 3,335 |
| Associate Members (30-32) | 1,981 |
| Associate Members (to the age of 29) | 19,031 |
| Total | 39,133 |

## People . . .

A. G. CHRISTIE, past-president and Hon. Mem. ASME, was honored by the Japan Society of Mechanical Engineers when they established the Christie Memorial Lecture. The first lecture was held in Tokyo at which time eight steam-engineering papers were presented before a large audience.

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A. C. MONTEITH, Hon. Mem. ASME, vice-president in charge of engineering, Westinghouse Electric Corporation, Pittsburgh, Pa., was nominated 1954-1955 president of the American Institute of Electrical Engineers.

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K. T. KELLER, Fellow ASME, chairman of the board of Chrysler Corporation, received an award from the Air Force for exceptional civilian service. On accepting the award he urged the Defense Department to expand the development of guided missiles. The award, presented by Air Force Secretary Harold E. Talbott, cited Mr. Keller's contributions during both World Wars and the Korean conflict. His work, the citation read, has advanced guided missiles "from drawing board to military reality." Mr. Keller was head of the Pentagon's missile program from October, 1950, to September, 1953.

James R. Bright, Mem. ASME, editor, *Modern Materials Handling*, has been selected by Harvard School of Business Administration to conduct a new research program in materials handling, and to lecture in the school's production department. He will continue his editorial contribution to MMH, in the capacity of consulting editor.

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Louis N. Hunter, Mem. ASME, vice-president of research, The National Radiator Company, Johnstown, Pa., was elected president of The American Society of Heating and Ventilating Engineers. Other officers elected at the Society's sixtieth annual meeting in Houston, Texas, are: first vice-president, John E. Haines, vice-president, Controls Division, Minneapolis-Honeywell Regulator Company, Minneapolis, Minn.; second vice-president, John W. James, Mem. ASME, vice-president in charge of research, McDonnell & Miller, Inc., Chicago, Ill.; treasurer, E. R. Queer, director of the Department of Engineering Research, The Pennsylvania State College, State College, Pa.; Council (three-year term): C. H. Pesterfield, associate professor of mechanical engineering, Michigan State College, East Lansing, Mich.; B. H. Spurlock, Jr., Mem. ASME, professor of mechanical engineering, University of Colorado, Boulder, Colo; John H. Fox, sales manager, Minneapolis-Honeywell Regulator Co., Ltd., Toronto, Ont., Can.; and A. J. Hess, president, Hess-Greiner & Polland, Los Angeles, Calif.

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Thorndike Saville, dean of the college of engineering at New York University, has been elected president of the Engineers Joint Council for 1954. Elected vice-president of the Council was C. S. Proctor, president, Moran, Proctor, Mueser and Rutledge and past-president ASCE.

The new Executive Committee with alternates consists of Dean Saville, ASEE, Mr. Proctor, ASCE; and the following engineering societies' representatives: W. M. Pierce, AIME; F. S. Blackall, Jr., past-president ASME; C. H. Capen, AWWA; W. J. Burrett, AIEE; L. R. Sanford, SNAME; C. C. Kirkbride, AIChE; the alternates are: G. Brooks Ernest, H. De Witt Smith, E. J. Kates, H. E. Jordan, M. D. Hooven, W. L. Green, N. W. Dougherty, and S. L. Tyler.

ASME representatives on EJC for 1954 include R. J. S. Pigott, past-president; R. L. Goetzenberger, F. S. Blackall, Jr., and C. E. Davies; *ex-officio*, L. K. Sillcox, ASME president; and the alternates are: E. J. Kates, L. K. Sillcox, D. W. R. Morgan, and Thompson Chandler.

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John Leland Atwood, president and a director of North American Aviation, Inc., has been elected president of the Institute of the Aeronautical Sciences for 1954. Other elected officials of the Institute for 1954 include four vice-presidents: William A. M. Burden, partner, William A. M. Burden and Company; E. S. Thompson, manager of contracts, Aircraft Gas-Turbine Division, General Electric Company; Edmund T. Price, president and general manager, Solar Aircraft Company; and John W. Larson, chief engineer, Fort Worth (Texas) Division, Consolidated Vultee Aircraft Corporation. The new treasurer is Elmer A. Sperry, Jr., vice-president and treasurer, Sperry Products, Inc.

**Former President Herbert Hoover received the 1953 gold medal of the International Benjamin Franklin Society and was the principal speaker, at the society's annual luncheon, January 23, at the Hotel Commodore, New York, N. Y., commemorating the 248th anniversary of the birth of Benjamin Franklin. The medal was awarded to Mr. Hoover, *left*, for "distinguished service to his country," and was presented by Brig. Gen. George L. Bliss, *right*, president of the society. The International Benjamin Franklin Society was founded in 1923 to "perpetuate the memory and teachings of Benjamin Franklin."**

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E. R. Granniss, Mem. ASME, manager, loss-prevention and engineering department, Royal Liverpool Group, New York, N. Y., represented ASME President L. K. Sillcox at The President's White House Conference on Highway Safety, held at Constitution Hall, Washington, D. C., February 17–19.

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Loyal V. Bewley, head of the department of electrical engineering at Lehigh University, was named dean of the college of engineering by the Lehigh University board of trustees.

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Edward McHugh, Mem. ASME, has been appointed dean of the school of engineering at Clarkson College of Technology. Dean McHugh is also director of Clarkson's division of industrial research and chairman of the mechanical-engineering department.

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James K. Finch, dean emeritus and Renwich professor emeritus of civil engineering, Columbia University, received an honorary DS degree at the first of three convocations being held this year to mark Columbia's Bicentennial anniversary. Forty-three other leaders in education, industry, the arts, and government received honorary degrees.

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Charles E. Wilson, Mem. ASME, former Director of Defense Mobilization, was principal speaker at the annual Edison Pioneers luncheon meeting, held Feb. 6, 1954, at the Waldorf-Astoria Hotel, New York, N. Y. The event was the occasion for a twofold celebration—the one-hundred-seventh birthday anniversary of Thomas Alva Edison and this year marking the seventy-fifth anniversary of the first practical incandescent electric lamp. Mr. Wilson was re-elected president of the group; Charles Edison, son of the inventor, was elected honorary president. Vice-presidents elected are N. R. Compton, J. V. N. Dorr, E. H. Kocher, Mem. ASME, and A. F. Tinnerholm. John E. Sloane, grandson of the inventor, was elected secretary; Miss A. B. Conclin, treasurer; and C. F. Coakley, historian.

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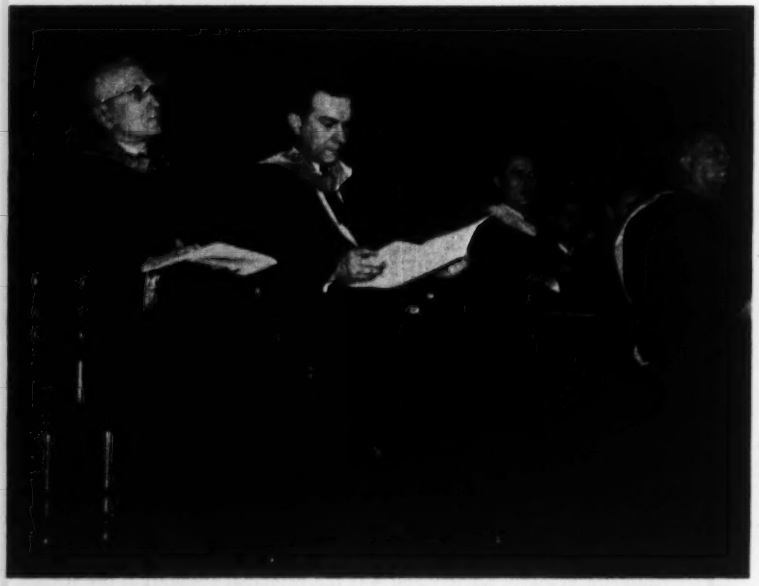
Harry Rubenkoenig, Mem. ASME, professor of railway mechanical engineering at Purdue University, has retired effective at the close of the first semester, 1954. Professor Rubenkoenig's retirement marks the close of an era during which Purdue was the center of railway research in the United States. During the heyday of the steam locomotive, each railroad designed its own equipment, and various pieces of machinery, particularly air brakes and brake shoes, were tested at the University before they could be approved by the American Railway Association.



**Lewis K. Sillcox, *left*, president and Hon. Mem. ASME, and John T. Rettaliata, Mem. ASME, president of Illinois Institute of Technology, Chicago, Ill., at January, 1954, commencement of Illinois Tech in Museum of Science and Industry. Dr. Sillcox was principal speaker at ceremonies. Dr. Rettaliata recently retired as regional vice-president of the ASME.**

For several years, Professor Rubenkoenig, a member of the Purdue staff since 1914, has been the only professor of railway mechanical engineering in the country. Part of Purdue's test equipment was dismantled during World War II and the remainder was removed to Chicago, Ill.

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GEORGE E. UHLENBECK and SAMUEL A. GOUDSMIT were the 1953 recipients of Research Corporation Award for their discovery of electron spin, a cornerstone of present atomic theory. The award was presented at the annual dinner of the foundation at the Waldorf-Astoria Hotel, New York, N. Y., January 22.

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ROBERT S. GREEN, chairman of the department of welding engineering at the Ohio State University, has been named executive director of the University's Engineering Experiment Station.

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JOSEPH P. LAWLOR, president, General Filter Company, recently assumed office as Mayor of Ames, Iowa. Mayor Lawlor, civil engineer and business executive, has been engaged in the development of water-conditioning equipment for municipal, private, and industrial use.

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Captain the Right Hon. PETER THORNEYCROFT, president of the United Kingdom Board of Trade, has accepted an invitation to open the seventh Canadian International Trade Fair in Toronto, Ont., on May 31, according to an announcement by the Right Hon. C. D. HOWE, Hon. Mem. ASME, Minister of Trade and Commerce.

**A. G. Ashcroft, Mem. ASME, vice-president and director of research and development, Alexander Smith, Inc., is to receive the Harold DeWitt Smith Memorial Medal for 1954. This is the fifth award of the medal by Committee D-13 on Textile Materials, of the American Society for Testing Materials. The medal will be presented to Mr. Ashcroft at a luncheon in his honor on March 18 during the spring meeting of Committee D-13, March 17 to 19, at the Statler Hotel, New York, N. Y.**

G. B. SCHUBAUER, formerly chief of the Aerodynamics Section of the National Bureau of Standards, has been appointed chief of the new Fluid Mechanics Section which will cover work formerly carried out in the Aerodynamics and Hydraulics Sections. The work will remain in the Mechanics Division.

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FREDERIC E. PAMP, JR., has been appointed manager of the general management division of the American Management Association and will be responsible for program planning of National conferences and small-group seminars dealing with general-management subjects.

**The Newcomen Medal, given only three times before in the history of the U. S. branch of The Newcomen Society, was awarded January 19, in Philadelphia, Pa., to William H. Rowand, Mem. ASME, vice-president of The Babcock & Wilcox Company of New York, N. Y., at a joint meeting of the Society and The Franklin Institute, in honor of Benjamin Franklin's birthday. Previous recipients of the award for achievement in the field of steam were Vice-Admiral Harold G. Bowen, Hon. Mem. ASME, in 1944; Everett G. Ackart, 1947; and Isaac Harter, Fellow ASME, 1950. Foremost among Mr. Rowand's contributions to steam progress, which led to his nomination for the medal, was his invention, in 1936, of the cyclone-steam separator.**

## Plans for 1954 ASME Semi-Annual Meeting Shaping Up

THE theme of the ASME Semi-Annual Meeting which will be held in Pittsburgh, Pa., June 20–24, at the William Penn Hotel, is "Community Progress—A Challenge to Engineers." At the present time the tentative program shows that there will be about 43 sessions and possibly two or three plant trips. Also at this stage in the planning of the program, the participating divisions are: Aviation, Education, Fuels, Gas Turbine Power,

Heat Transfer, Hydraulics, Instruments and Regulators, Machine Design, Management, Metal Processing, Materials Handling, Metals Engineering, Nuclear Energy, Power, Process Industry, Production Engineering, Rubber and Plastics, Safety, Lubrication, and Junior. The American Rocket Society, an affiliate of ASME, will also participate in the sessions of the meeting.

## Engineers to See a Lot of Brazil This Year

As part of the yearlong observance of the four hundredth Anniversary of the founding of the City of Sao Paulo, a large number of international organizations are holding meetings and conventions in Brazil.

Three of these meetings which are of particular interest and importance to engineers have been scheduled for this summer with dates arranged to permit participation in all three.

The Sectional Meeting of the World Power Conference will take place in Rio de Janeiro, July 25 to August 10. The U. S. National Committee for the World Power Conference is working with the Department of State in organizing the U. S. delegation.

The Inter-American Association of Sanitary Engineers has selected Sao Paulo for their meeting. It will take place July 25 to 31. The U. S. delegation is now being formed.

The Third Convention of the Pan-American Federation of Engineering Societies (UPADI) will also meet in Sao Paulo, August 2 to 12. This meeting will attract engineers of all societies from Latin America, Canada, and the United States. Engineers Joint Council is currently selecting the U. S. delegates and alternates.

**General Arrangements Committee for ASME Semi-Annual Meeting, Pittsburgh, Pa., June 20–24, 1954. Standing, *left to right,* J. R. Aikins, Publicity; K. F. Treschow, Hotels; C. R. Burlingame, Plant Trips; J. McK. MacLachlan, Plant Trips; Prof. D. W. Ver Planck, Vice-Chairman; P. D. Oesterle, Reception; R. S. MacQuown, Printing and Signs; H. R. Fulton, Information and Registration; and M. J. Wohlgemuth, Entertainment. Seated, *left to right,* Prof. N. L. Buck, Technical Events; P. T. Lagrone, Entertainment; J. T. Bunting, Chairman; Mrs. R. W. Leathers, Ladies; Mrs. P. D. Oesterle, Ladies; and R. A. Cederberg, Printing and Signs. Not Shown: E. W. Jacobson, Technical Events Committee; Tomlinson Fort, Finance Committee; and R. W. Leathers, Secretary.**

# Program Announced for Third American Power Conference to Be Held in Chicago, Ill.

### Sherman Hotel Headquarters—Light's Diamond Jubilee Celebration and 52nd National Power Show Features

THE Third American Power Conference will be held March 24–26, 1954, at the Sherman Hotel in Chicago, Ill. The Conference is sponsored by Illinois Institute of Technology in co-operation with 12 universities and ten local and national engineering societies.

The American Power Conference was organized in 1952 as successor to the Midwest Power Conference. The purpose of the Conference is to provide a national forum for discussion of problems and for the exchange of information concerning matters of interest to the power industry and associated lines of endeavor. The program is planned with emphasis on the broad over-all aspects of the subject, rather than the intricate technical details. Papers emphasize the practical rather than the theoretical point of view.

There are several symposiums scheduled on such subjects as demineralization, network analyzers, and computing aids, and panels to further discuss other power topics. Government, education, industrial, and engineering leaders will address the various luncheons and dinners which will round out a distinctly significant program.

### Light's Diamond Jubilee Celebration

The year 1954 marks the seventy-fifth anniversary of the invention of the electric light by Thomas A. Edison. In commemoration of this event celebrations are being planned in all the major cities of the United States. One of these will be in Chicago at the American Power Conference. As a part of this celebration the Conference is arranging a special Diamond Jubilee Dinner and other appropriate activities. Colter H. Moses, chairman, Arkansas Power and Light Company, Little Rock, Ark., will be the principal speaker of the evening.

Several tours of both a technical and cultural nature will be available to delegates and visitors, many of whom are planning trips to other parts of South America. To facilitate travel arrangements, the North Shore Travel Center has been appointed official travel agent for the three organizations. Information on travel and meetings may be secured from the Center at 609 Plandome Road, Manhasset, Long Island, N. Y., or from the sponsoring organizations.

### National Power Show

The National Association of Power Engineers will hold its fifty-second National Power Show at the Sherman Hotel concurrently with the Conference. Exhibits of interest to the power industry will be on display every afternoon and evening from March 23 through March 26.

### Proceedings of the Conference

Each year all the papers and addresses delivered at the Conference are published in a clothbound volume called "The Proceedings of the American Power Conference." A copy of this volume will be mailed without further charge to each registrant. Additional copies may be ordered either at the registration desk or by mail. The price of the volume has been announced as $6 a copy.

### Conference Program

The Conference program follows:

**WEDNESDAY, MARCH 24**

**9:00 a.m. Registration**

**10:00 a.m. Opening Meeting**

Invocation: *The Reverend Kenneth Hildebrand DD,* Minister, The Central Church of Chicago"

**Address of Welcome**: *Lennox R. Lohr*, president, Museum of Science and Industry, and general chairman, Lights Diamond Jubilee Celebration of American Power Conference

**Research and the Electric-Power Industry,** by *J. E. Hobson*, director, Stanford Research Institute, Stanford, Calif., and *William A. Lewis*, dean of the Graduate School, Illinois Institute of Technology

**Address**: *Vice-Admiral Harold G. Bowen*, executive director, Thomas A. Edison Foundation, West Orange, N. J.

**Address**: *Arthur S. Flemming*, Director of Defense Mobilization, Washington, D. C.

**12:15 p.m. American Power Conference Luncheon,** sponsored by The American Society of Mechanical Engineers.

**Chairman**: L. K. Sillcox, President ASME
**Vice-Chairman**: M. F. Obert, chairman, Chicago Section, ASME
**Speaker**: **The Power Industry—A Challenge to Engineers,** by *Walter H. Sammis*, president, Ohio Edison Company, Akron, Ohio, and president, Edison Electric Institute

**2:00 p.m. Central-Station Steam Generation**

**Performance of New Controlled-Circulation Boilers,** by *E. M. Powell*, assistant chief engineer, Combustion Engineering, Inc., New York, N. Y.

**Cyclone-Furnace-Fired Boilers,** by *George W. Kessler*, assistant chief engineer, The Babcock & Wilcox Co., New York, N. Y.

**Pulsation-Induced Vibration in Utility Steam-Generation Units,** by *Raymond C. Baird*, research consultant, The Fluor Corporation, Ltd., Los Angeles, Calif.

**The Present and Future Status of the Fly-Ash Disposal Problem,** by *C. M. Weinheimer*, head of mechanical division, The Detroit Edison Company, Detroit, Mich.

**2:00 p.m. Hydroelectric Power Development in the United States**

**The Role of the Corps of Engineers in the Development of Water Resources,** by *Brigadier General E. C. Itschner*, assistant chief of Engineers for Civil Works; *C. H. Giroux*, special assistant; *Gail A. Hathaway*, special assistant; and *Colonel G. J. Zimmerman*, chief, Technical Liaison Division, Office of the Chief of Engineers, Gravelly Point, Va.

**The Federal Multiple-Purpose Project—Its Role in the West,** by *H. B. Taliaferro*, chief, Power Division; and *W. L. Newmeyer*, assistant chief, Power Division, Bureau of Reclamation, United States Department of the Interior, Washington, D. C.

**The Hydroelectric System of the Southern California Edison Company,** by *W. L. Chadwick*, Southern California Edison Co., Los Angeles, Calif.

**2:00 p.m. Industrial Plant**

**Scale Modeling—A Practical Engineering and Construction Tool,** by *James A. Carroll*, department head, Engineering Division, The Procter and Gamble Company, Cincinnati, Ohio

**Selection, Maintenance, and Piping Practice in Industrial Plants,** by *Robert J. Pinske*, power-plant engineer, Crane Company, Chicago, Ill.

**Planning and Installing an Electrical System in a Rapidly Growing Industrial Plant,** by *Hans Ederegger, Jr.*, sales engineer, I. L. Weldy and Associates, Chicago, Ill., and *M. W. Stehr*, supervising industrial engineer, Power Sales Division, Wisconsin Electric Power Company, Milwaukee, Wis.

**2:00 p.m. Station Apparatus**

**Continuity of Service at Distribution Voltages by Means of Ring Bus,** by *Dorio Dalasta*, application engineer, switchgear department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

**Transformer-Sound Levels,** by *T. R. Specht* and *L. R. Rademacher*, transformer engineers, Westinghouse Electric Corporation, Sharon, Pa.

**3:30 p.m. Industrial Electrical**

**Recent Developments in Pipe-Line Electrification,** by *Merritt Hyde*, Petroleum Industry Engineer, Westinghouse Electric Corporation, East Pittsburgh, Pa.

**Open-Hearth Versus Electric-Furnace Economics and Their Significance to the Power Industry,** by *David D. Moore*, chief, Engineering Economics Division, Battelle Memorial Institute, Columbus, Ohio

**7:00 p.m. Lights Diamond Jubilee Dinner**

The Varsity Glee Club of Purdue University, *Albert P. Stewart*, director

**Message from the President of the United States**
**Presiding**: Lenox R. Lohr
**Speaker**: *Colter Hamilton Moses*, chairman, Arkansas Power and Light Company

## THURSDAY, March 25

**9:00 a.m. Central-Station Steam Turbines**

**Steam-Turbine Development,** by *Clarence C. Franck*, manager, Large Turbine Engineering, Steam Division, Westinghouse Electric Corporation, Philadelphia, Pa.

**Trends in Design of Present-Day Steam Turbines,** by *Charles D. Wilson*, engineer-in-charge of steam-turbine design; and *Ellis P. Hansen*, engineer, steam-turbine department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis.

**The Steam Turbine of Tomorrow,** by *R. S. Neblett*, manager, marketing, Turbine Division, General Electric Company, Schenectady, N. Y.

**9:00 a.m. Fuel Economics**

**Petroleum's Place in the Fuel Market,** by *C. J. Hedlund*, head, Petroleum Economics Division, Standard Oil Co. (New Jersey), New York, N. Y.

**Economic Trends in the Use of Natural Gas,** by *Richard Gonsales*, economist, Humble Oil Company, Houston, Texas

**Future of Coal in Power Generation,** by *G. A. Lamb*, manager of business surveys, Pittsburgh Consolidation Coal Co., Pittsburgh, Pa.

**Nuclear Fuels for Power Generation,** by *W. F. Friend*, mechanical engineer, Ebasco Services, Inc., New York, N. Y.

**9:00 a.m. Year-Round Air Conditioning**

**Factors Affecting the Installation of Year-Round Air Conditioning in Homes,** by *L. H. Hirschbach*, manager, builder sales, General Electric Co., Bloomfield, N. J.

**Climatic and Geographic Evaluation of Potential Comfort Air-Conditioning Loads,** by *J. R. Hertzler*, vice-president and general sales manager; and *V. T. Karlorie*, manager, market research, York Corporation, York, Pa.

**10:30 a.m. Water Technology (I)**

**Evaluation of Several Alkaline Compounds for Controlling Corrosion in Boiler-Feedwater Systems,** by *J. M. Decker*, senior research engineer, engineering laboratory and research department; and *J. C. Marsh*, technical engineer, Marysville Power Plant, The Detroit Edison Co., Detroit, Mich.

**High-Temperature Water for Process Heating Combined With Power Production,** by *P. L. Geiringer*, chief engineer; and *Floyd Hasselriis*, applications engineer, American Hydrotherm Corp., New York, N. Y.

**10:30 a.m. Distribution Systems**

**Electric Distribution for Future Loads,** by *R. E. Pierce*, consulting electrical engineer, *W. R. Bullard*, and *Chase Hutchinson*, electrical engineers, Ebasco Services, Inc., New York, N. Y.

**Adequate Wiring for Appliance Loads,** by *L. G. Smith*, superintendent, electric distribution department, Consolidated Gas, Electric Light and Power Co., Baltimore, Md.

**12:15 p.m. American Power Conference Luncheon**

Chairman: Elgin B. Robertson, president, AIEE
Vice-Chairman: R. W. Jones, chairman, Chicago Section, AIEE
Speaker: *Jerome K. Kuykendall*, chairman, Federal Power Commission, Washington, D. C.

**2:00 p.m. Central-Station Steam-Power Plants**

**Supercritical-Pressure Steam-Power Cycles,** by *Jerome Bartels*, associate professor of mechanical engineering, Polytechnic Institute of Brooklyn, and associated with Gibbs & Hill, Inc., New York, N. Y.

**The Gallatin Steam Plant of the Tennessee Valley Authority,** by *C. E. Blee*, chief engineer, and *H. J. Petersen*, head mechanical engineer, Tennessee Valley Authority, Knoxville, Tenn.

**The Economy of Large Generating Units,** by *H. P. Seelye*, manager of engineering, and *W. W. Brown*, chief mechanical engineer, planning and project engineering department, The Detroit Edison Company, Detroit, Mich.

**2:00 p.m. Water Technology (II), Symposium on Demineralization**

**Demineralized Water for 1500-Psi Steam Plant—Design Aspects,** by *C. R. Stewart*, Stone and Webster Engineering Corp., Boston, Mass.

**Demineralized Water for 1500-Psi Steam Plant—Operating Aspects,** by *W. B. Gurney*, efficiency engineer, Gulf States Utilities, Baton Rouge, La.

**Automatic Mixed-Bed Demineralizing at the Niagara Mohawk Power Company,** by *Durando Miller*, assistant manager, The Permutit Co., New York, N. Y., and *T. J. Finnegan*, chemist, Niagara Mohawk Power Company, Buffalo, N. Y.

**The Expected Life of Anion Exchangers Under Various Conditions of Dionizer Design and Operation,** by *Louis Wirth*, special service engineer, Ion Exchange Division, National Aluminate Corp., Chicago, Ill.

**2:00 p.m. Industrial Power Plants—Economics Aspects**

**Economic Factors Affecting Selection and Replacement of Power-Plant Equipment,** by *Gerald J. Matchett*, director, Dynamic Equipment Policy Research Center, Illinois Institute of Technology

**Hawthorne Power-Plant-Rehabilitation Economics,** by *C. E. Morrow*, engineer, Power and Service Facilities Engineering, and *R. F. Born*, mechanical engineer, Hawthorne Station, Western Electric Company, Chicago, Ill.

**2:00 p.m. Electrical Systems**

**Load Structure of a Modern Electric-Utility System,** by *C. W. Barry*, rate-research engineer, Philadelphia Electric Company, Philadelphia, Pa.

**Service Standards in Relation to Reserve and System Design,** by *W. J. Lyman*, vice-president, and *V. E. Hill*, electrical planning engineer, Duquesne Light Co., Pittsburgh, Pa.

**3:30 p.m. Cables for Transmission and Distribution**

**Aerial Cable for Distribution Systems,** by *H. M. Bankus* and *F. C. Van Wormer*, application engineers, General Electric Company, Schenectady, N. Y.

**Aluminum for Underground-Cable Sheaths,** by *K. S. Wyatt*, Phelps Dodge Cooper Products Corp., Yonkers, N. Y.

**6:45 p.m. All Engineers Dinner**

Presiding: J. Roscoe Miller, MD, president, Northwestern University, Evanston, Ill.
Speaker: The Honorable *Douglas McKay*, Secretary of the Interior, Washington, D. C.

## FRIDAY, MARCH 26

**9:00 a.m. Nuclear Energy**

**Economic Aspects of Various Types of Nuclear Reactors,** by *D. H. Loughridge*, dean of Northwestern Technological Institute, Evanston, Ill.

**Technology of the Use of High-Pressure Water for Reactors,** by *A. Amorosi*, associate director, Reactor Engineering Division, Argonne National Laboratory, Lemont, Ill.

**Problems of Operation of Nuclear-Power Plants,** by *R. L. Doan*, manager, Atomic Energy Division, Phillips Petroleum Co., National Reactor Testing Station, Idaho Falls, Idaho

**9:00 a.m. Water Technology (III)**

**Water Problems in the Nuclear-Power Field,** by *R. C. Ulmer*, Nuclear Power Division, Combustion Engineering, Inc., New York, N. Y.

**Boilers and Boiler Waters—Interlocking Advances in Design,** by *H. M. Rivers*, director of engineering service, and *S. R. Osborne*, staff engineer, Hall Laboratories, Pittsburgh, Pa.

**9:00 a.m. Steam and Diesel Power Plants**

**Toward a More Successful Operation of Diesel Generating Facilities,** by *R. J. Daverman*, partner; *J. A. DeWinter*, chief electrical engineer; and *J. H. Kaol*, electrical engineer, J. & G. Daverman Co., Grand Rapids, Mich.

**Steam Versus Diesel Power Plants,** by *C. M. Stanley*, Stanley Engineering Company, Muscatine, Iowa

**9:00 a.m. Electronics—Sponsored by Electronics Group, Chicago Section, AIEE**

**Operating Experience With Microwaves in a Power System,** by *E. A. Shultz*, manager of Electric Operations, and *H. G. Goers*, relay and communications engineer, Illinois Power Company, Decatur, Ill.

**Progress of Carrier and Microwave and Power-System Operation**, by *C. W. Broadway*, communications engineer, Hydroelectric Power Commission of Ontario, Toronto, Can.

**10:30 a.m. Water Technology (IV)**

**Silica Removal by Salt Splitting Without Demineralizing,** by *S. B. Applebaum*, manager, Water Treatment Division, Cochrane Corp., Philadelphia, Pa., and *B. W. Dickerson*, engineering department, Hercules Power Co., Wilmington, Del.

**Some Chemical Aspects of Hot Process-Hot Zeolite Plant Performance,** by *M. Lane*, technical manager, and *J. H. Duff*, chemical engineer, Craver Water Conditioning Co., New York, N. Y.

**10:30 a.m. Gas Turbines for Power Generation**

**Gas Turbines for the Power Industry,** by *T. J. Putz*, manager, gas-turbine engineering, Westinghouse Electric Corp., Philadelphia, Pa.

**A New Power Cycle Combines Gas Turbine With Steam Turbines,** by *L. S. Gee*, mechanical engineer, West Texas Utilities Company, Abilene, Texas

**10:30 a.m. Circuit Breakers**

**High-Voltage Airblast Breakers for High-Interrupting Capacity,** by *Hans Meyer*, Brown, Boveri and Co., Baden, Switzerland, and *W. R. Sireuli*, vice-president, Brown, Boveri Corp., New York, N. Y.

**Modern High-Voltage Circuit Breakers With Low-Oil Content,** by *Paul Wildi*, Pacific Oerlikon Company, Tacoma, Wash.

**12:15 p.m. American Power Conference Luncheon,** sponsored by the Western Society of Engineers

Chairman: L. C. McCabe, chief, Fuels and Explosives Division, Bureau of Mines, U. S. Department of the Interior, Washington, D. C.
Vice-Chairman: J. F. Sullivan, Jr., vice-president, Western Society of Engineers, Chicago, Ill.
Speaker: *T. E. Murray*, member, Atomic Energy Commission, Washington, D. C.

**2:00 p.m. Developments in Gas Turbines and Diesel Engines**

**Performance of 2400-Hp "Trainmaster" Diesel Locomotives,** by *Robert Aldak*, Fairbanks Morse and Company, Chicago, Ill.

**Use of Gas-Turbine Electric Locomotives on the Union Pacific Railroad Company,** by *F. Fahlund*, general mechanical engineer, Union Pacific Railroad Co., Omaha, Neb.

**Factors Associated With Use of Gas Turbines for Automotive Applications,** by *J. H. Bonin*, supervisor, Heat-Power Research, and *R. A. Harmon*, research engineer, Armour Research Foundation, Chicago, Ill.

**Gas Turbines in the Steel Industry,** by *G. H. Krapf*, technical assistant, Fuel and Power, Steel Operating Division, United States Steel Corp., Pittsburgh, Pa.

**2:00 p.m. Industrial Steam Generation**

**Some Economic Factors Influencing Industrial Boiler Manufacture,** by *C. E. Miller*, manager, Industrial Division, Combustion Engineering, Inc., New York, N. Y.

**Operating Experience With a Multifuel Stoker-Fired Boiler,** by *G. G. Bachman*, superintendent of Power, Omaha Public Power District, Omaha, Neb.

**Industrial Operating Experience With Cyclone-Fired Boilers,** by *L. L. Moran*, operating manager, power department, The Dow Chemical Company, Midland, Mich.

**2:00 p.m. Symposium on Network Analyzers and Computing Aids**

*Group A—Network Analyzers*

**The Co-Ordinated Use of A-C and D-C Network Analyzers,** by *J. A. Casazza* and *W. S. Ku*, assistant engineers, Public Service Electric and Gas Company, Newark, N. J.

**Network Analyzer Operational Problems and Methods,** by *M. E. Gillihan*, electrical engineer associate, Department of Water and Power, Los Angeles, Calif.

*Group B—Digital Computers*

**Applications of Digital Analysis to Power-System Problems,** by *G. W. Bills*, Bonneville Power Administration, Portland, Ore.

**Digital Computers in Utility-Engineering Problems,** by *F. J. Maginnis*, General Electric Company, Schenectady, N. Y.

**Digital Computers in Power-System Engineering,** by *W. D. Trudgen*, The Detroit Edison Company, Detroit, Mich.

**2:00 p.m. Electrical Circuit Breakers**

**Recent Developments in Large Power-Circuit Breakers,** by *A. W. Hill*, manager, circuit-breaker engineering, Westinghouse Electric Corp., East Pittsburgh, Pa.

**Trends in Design and Application of Tank-Type Power-Circuit Breakers,** by *L. J. Linde* and *A. E. Kilgour*, Allis-Chalmers Manufacturing Co., Boston, Mass.

**Switchgear Equipment for Supervoltage Transmission,** by *R. M. Bennett*, engineer, Switchgear Division, General Electric Company, Philadelphia, Pa.

# Sixth Industrial-Engineering Institute Well Attended at University of California

## Meetings Held in Los Angeles and Berkeley

The sixth annual Industrial Engineering Institute of the University of California proved to be of great interest to a large number of engineers and executives of the western states. Over seven-hundred engineers and managers attended the two-day sessions held at the Berkeley Campus on January 29 and 30 and at Los Angeles on February 1 and 2. These meetings have become an outstanding annual contribution to the growth of industrial engineering and management on the West Coast.

The purposes of the Institute are to present new and important developments and practical applications in the field of industrial engineering and management; to provide an impartial forum for the discussion of these topics; and to present the results of industrial-engineering research performance at the University of California and throughout the country.

Among the topics discussed were "Electronics Enters Industrial Engineering," "Reducing Costs Through Paper-Work Simplification," "Helping People to Accept New Ideas," and "The Application of Industrial-Engineering Techniques to Purchasing." The production-engineering sessions included papers on "Management's Stake in Industrial Research," "Minimizing Manufacturing Costs Through Effective Design," "Selection of the Most Economical Method for Producing Parts on Punch-Press Tools," "Human Factors in Engineering Design," and a "Tool-Wear Study in Machining." Continuing the efforts of the Institute to define and discuss the problems of small business, papers were presented on "The Evaluation of the Industrial-Engineering Program in Small-Plant Management" "Teamwork: The Key to Increased Productivity in a Small Business," "Study of Production Management in Small Manufacturing Companies," and "Automation in Small Plants."

The American Society of Mechanical Engineers is an active sponsor of these annual conferences and James N. Landis, chairman of the San Francisco Section of ASME, served as chairman of the production-engineering sessions. Prof. Bruce G. McCauley, Assoc. Mem. ASME, general chairman of the Institute, and a member of the mechanical-engineering staff at Berkeley, has expressed much appreciation for the continuing support of ASME and other co-operating professional societies. The chairman of the production-engineering sessions at Los Angeles was Francis P. Baeyertz, chairman of the Southern California Section of ASME. The chairman of the northern sessions of the Institute was James T. Lapsley, who is also on the mechanical-engineering faculty at Berkeley; and Joseph D. Carrabino, Assoc. Mem. ASME, of the business administration staff at UCLA, served as chairman of the Los Angeles sessions.

The Institute consistently draws the largest attendance for programs of its kind on the West Coast. Engineers attended from almost

**Motion and Time-Study Laboratory at University of California: Student demonstrating method-improvement project to spectators during tour of the laboratory during the conference.**

**Record attendance at Industrial Engineering Institute: Part of the audience of more than 700 engineers who attended the sessions which were held at Berkeley and Los Angeles.**

all of the western states and some came even greater distances. Published proceedings of the conference will be distributed to those in attendance and will be available to the general public at a later date.

Planning is already under way for the seventh Institute scheduled for January, 1955, so that these conferences may continue to invigorate the progress of industrial engineering on the West Coast.

# ASME Regional Student Conferences Schedule Announced for 1954

## Twelve Conferences to Be Held During March–May

DURING the months of March, April, and May, the members of the 135 student branches of The American Society of Mechanical Engineers will convene at 12 Regional Student Conferences, which are held annually to select the regional winners of the prize papers. The papers entered in the competition are those which were selected in local papers meetings.

Arrangements are made to have the conferences in as centrally located a college or university as possible to minimize the travel distance and to insure maximum attendance. In the East the regions are geographically small and one conference is generally sufficient. In the West, however, where the regional divisions are vaster, two or three conferences are required. The student conferences are intended to be the climax of the scholastic student-branch year. However, as many meetings as possible are planned to run concurrently with a regular ASME meeting. This year the student branches of Regions IV and VIII will meet at the same time as the Regional Administrative Committee Meeting, in Knoxville, Tenn., and the Region VIII Annual Regional Meeting. A list of the student conferences is printed elsewhere on this page.

The program for the student conferences is similar to that of Society national meetings. The registration period is followed by technical sessions, at which time the papers are presented; luncheons and dinners complete these enjoyable and educational events. The local industries, in co-operation with the host branch and the ASME Section, often arrange inspection trips to plants.

The Society, in part, defrays the travel expenses from the student branch to the conference and further encourages keen competition by granting each conference $100 in prize money. The Old Guard of the Society also contributes $10 as a prize to each conference.

# Symposium on Operations Research Planned for Kansas City in April

MIDWEST Research Institute, Kansas City, Mo., announced that it has completed final arrangements for a symposium which will be held in the grand ballroom of the Hotel President, Kansas City, April 8 and 9, on "Operations Research in Business and Industry." The success of last year's symposium on Industrial Applications of Automatic Computing Equipment led Midwest to sponsor this symposium for industrial and business leaders.

For several months the Institute has been lining up the top talent in the field of operations research to explain the techniques and describe case histories, and the program promises to be one of the fullest and most comprehensive of its kind ever offered in the United States. Different papers will cover operations research in the fields of marketing, industry, and finance.

The first of its kind held in Kansas City, it is expected to attract over four hundred top industrial and business leaders. Keynote speaker for the sessions will be C. West Churchman, director, Operations Research Group, Engineering Administration Department, Case Institute of Technology. Another noted speaker from Case Institute will be Russell L. Ackoff.

Other authorities in this research field who will participate include J. H. Davidson, consulting engineer, Statistical Methods, General Electric Company; Sherman Kingsbury of Arthur D. Little, Inc.; Earl Lamm, research director, Paul B. Mulligan Company; Prof. S. B. Littauer, department of industrial engineering, Columbia University; T. A. Mortensen, Midwest Research Institute; William Orchard-Hays, Numerical Analysis Group, Rand Corporation; William Prager, chairman, Physical Sciences Council, Brown University; and E. C. Varnum, head, Operations Research, Barber-Colman Company.

Operations research is a recently developed technique which applies the approach of the physical scientist to the solution of nontechnical problems such as occur in the office and in the factory. The program is being organized to give business, financial, and industrial leaders an opportunity to appraise this new technique for increasing efficiency in everyday operations and in future planning.

An article describing operations research will be found on pages 231–235 of this issue. These speakers have been asked to emphasize case-history presentations showing concrete illustrations where this new type of thinking has paid dividends.

A registration fee of $20 covers admittance to all sessions, including a cocktail party. Each registrant will receive a copy of the symposium proceedings following the meeting.

For registration details write to Martin Goland, Director for Engineering Sciences, Midwest Research Institute, 4049 Pennsylvania, Kansas City, Mo.

# 1954 ASME Regional Student Conferences

| *Region* | *Place* | *Date* | *Host* |
|---|---|---|---|
| I New England | Potsdam, N. Y. | May 7–8 | Clarkson College |
| II Eastern | Brooklyn, N. Y. | April 14 | Polytechnic Institute of Brooklyn |
| III Alleghenies | Rochester, N. Y. | April 30–May 1 | University of Rochester |
| IV Southern | Knoxville, Tenn. | March 26–27 (Followed by RAC Meeting) | University of Tennessee |
| V Midwest | Detroit, Mich. | April 26–27 | Wayne University |
| VI Northern Tier | Grand Forks, N. Dak. | April 26–27 | University of North Dakota |
| VI Southern Tier | Louisville, Ky. | April 8–9 | University of Louisville |
| VII Pacific Northwest | Vancouver, B. C., Can. | April 28–May 1 | University of British Columbia |
| VII Pacific Southwest | Tucson, Ariz. | April 30–May 1 | University of Arizona |
| VIII Northern Tier | Tulsa, Okla. | April 26–27 | Mid-Continent Section |
| | (Concurrent with Region VIII Regional Meeting) | | |
| VIII Rocky Mountain Tier | Boulder, Colo. | April 2–3 | University of Colorado |
| VIII Southern Tier | Ruston, La. | March 29–30 | Louisiana Polytechnic Institute |

## ASME Calendar of Coming Events

**March 10–12**
ASME International Meeting, Hotel Del Prado, Mexico, D. F.
*(Final date for submitting papers was Nov. 1, 1953)*

**March 31–April 1**
ASME Management-Engineering Conference, Benjamin Franklin Hotel, Philadelphia, Pa.
*(Final date for submitting papers was Nov. 1, 1953)*

**April 25–28**
ASME Region VIII, annual meeting to be held concurrently with ASME Boiler and Pressure Vessel Code Committee annual meeting, Tulsa, Okla.

**June 14–17**
ASME Oil and Gas Power Conference, Hotel Muehlebach, Kansas City, Mo.
*(Final date for submitting papers was Feb. 1, 1954)*

**June 14–18**
Second U. S. National Congress of Applied Mechanics, University of Michigan, Ann Arbor, Mich.

**June 20–24**
ASME Semi-Annual Meeting, William Penn Hotel, Pittsburgh, Pa.
*(Final date for submitting papers was Feb. 1, 1954)*

**Sept. 8–10**
ASME Fall Meeting, Hotel Schroeder, Milwaukee, Wis.
*(Final date for submitting papers—May 1, 1954)*

**Sept. 13–24**
ASME Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Commercial Museum and Convention Hall, Philadelphia, Pa.
*(Final date for submitting papers—May 1, 1954)*

**Sept. 26–29**
ASME Petroleum-Mechanical Engineering Conference, Statler Hotel, Los Angeles, Calif.
*(Final date for submitting papers—May 1, 1954)*

**Oct. 28–29**
ASME-AIME Joint Fuels Conference, William Penn Hotel, Pittsburgh, Pa.
*(Final date for submitting papers—June 1, 1954)*

**Nov. 28–Dec. 3**
ASME Annual Meeting, Statler Hotel, New York, N. Y.

## Meetings of Other Societies

**March 16–18**
American Railway Engineering Association, annual meeting, Palmer House, Chicago, Ill.

**March 29–31**
Society of Automotive Engineers, national production meeting, Drake Hotel, Chicago, Ill.

**April 5–6**
The Society of the Plastics Industry (Canada), twelfth annual conference, Mount Royal Hotel, Montreal, Que., Can.

**April 5–7**
American Society of Lubrication Engineers, annual meeting and exhibition, Netherland-Plaza Hotel, Cincinnati, Ohio.

**April 5–7**
American Institute of Mining and Metallurgical Engineers, open-hearth conference, Palmer House, Chicago, Ill.

**April 11–16**
American Association of Petroleum Geologists, annual convention, St. Louis, Mo.

**April 12–15**
Society of Automotive Engineers, national aeronautics meeting, Statler Hotel, New York, N. Y.

**April 14–16**
Society for Experimental Stress Analysis, spring meeting, Netherland-Plaza Hotel, Cincinnati, Ohio.

**April 15–16**
American Institute of Electrical Engineers, southern textile conference, Georgia Institute of Technology, Atlanta, Ga.

*Copyright photo—IAS*

**Charles A. Lindbergh, *left*, receives the Daniel Guggenheim Medal from Harry F. Guggenheim at the IAS Honors Night Dinner**

# Charles A. Lindbergh Receives Guggenheim Award at IAS Meeting Honors Night Dinner

## Col. Lindbergh Stressed the Development of Human Qualities to Insure Long-Term Survival

"AVIATION has been so successful that, together with other branches of modern science, it has revolutionized the environment of man," Charles A. Lindbergh told the 1200 guests at the Honors Night Dinner of the annual meeting of the Institute of the Aeronautical Sciences, at the Astor Hotel, New York, N. Y.

"Short-term survival may depend on the knowledge of nuclear physicists and the performance of supersonic aircraft," he said, "but long-term survival depends alone on the character of man."

"This mid-century generation we represent stands on amazing accomplishments," he said, "but faces alarming problems. We have wiped out a city with a single bomb, but how can we use this fact to heighten our civilization? In emphasizing force, efficiency, and speed, are we losing humility, simplicity, and tranquility without which we cannot hold our own?"

"These are the problems of human power. We have shown what man can make of science. Now it is a question of what our scientific environment will make of man. The solution lies in each individual.

"Unexpanded by the time dimension, flattened on a momentary, mental screen," he noted, "the chaos of our modern world is staggering. We watch assemblies and conferences bog down until we realize that man has not the wisdom to solve his problems by any sweeping, detailed plan. But when we add the scope of time, and release in it the catalyst of faith, the future clarifies, and we see that, within the bounds of natural law, man's destiny is shaped by man's desire."

He received the Daniel Guggenheim Medal from Harry F. Guggenheim for outstanding contributions to aeronautical development. Four other awards and the granting of twelve fellowships were announced at the dinner.

Capt. Charles F. Gell of the Navy Medical Corps received the John Jeffries Award; Donald Coles of the California Institute of Technology received the Lawrence Sperry Award; Henry T. Harrison, Jr., chief meteorologist of United Air Lines, Inc., was the recipient of the Robert M. Losey Award; and Ernest G. Stout, staff engineer at Consolidated Vultee Aircraft Corporation's San Diego division, received the Sylvanus Albert Reed Award.

# *Junior Forum* . . .

Conducted by Joseph Schmerler, Assoc. Mem. ASME

## How to Create Your Own Opportunities for Success in Engineering

By Charles J. Hudson[1]

THE title of this article has a suggestion that creating opportunities means financial success. The purpose in creating and influencing one's opportunities, however, besides direct money gain, is greater responsibility, higher office, greater prestige in an organization, being the boss perhaps, or just plain love of one's work, contentment, and satisfaction in the accomplishment of a job well done. As you grow older, even though you do not attain the presidency of the company for which you work, I believe that you will have influenced your opportunities if you can truthfully say, "I have done a good job."

For the past 20 years, at least two or three times a year, a fellow engineer has come to see me about some kind of trouble. The pattern is usually the same. He is about 30-odd years old, married, and has perhaps two or three children. Having been perfectly content with his work and pay previously he has suddenly realized that perhaps ten years from now he will be doing exactly the same job at the same salary. The question he asks is, "How can I improve my situation so that I can have a better, more responsible job ten years from now?" There is quite a problem before this man and its solution is difficult.

My general reply, after listening and talking with him, has been that he should work at his job in such a way that someone will come along and say, "I want that man. He is always busy. He is studious. He is a good workman. I want him." Exactly how one attains such a reputation, I do not know. No two people do it alike. However, I have six rules, as a guide, by which such opportunity can be created.

1 Like your work—love it.
2 Be active in technical societies.
3 Have an outside interest or two.
4 Take a part in home life.
5 Have a part in community life.
6 Believe in a higher authority.

### Like Your Work—Love It

I thoroughly believe that one cannot do his best unless he likes his work. Either the work is exactly to your liking, is what you have studied for and have always wanted to do, or you must learn to like it. If you are to make the most of your opportunity, and are in a kind of work which you did not anticipate, then you must learn to like it. The part which you do not like you should treat as a problem. Analyze it and solve it just as you would any mathematical problem.

When I worked in the Research Laboratory of the Norton Company we had to get out monthly reports. It was a chore I didn't like to do. When I analyzed it I found that the real reason why I didn't like it was that because I left it until the twenty-ninth of the month to do. It wasn't well written and not worthy of what I knew that I could do. I thereafter got into the habit of making short notes each day of what I did that day. Then, on the twenty-ninth or thirtieth of the month I didn't have to spend an hour or two thinking of what I had done on the fifth, sixth, or seventh, and it was a lot of fun to get that report accomplished before the other members of the laboratory, or before I was reminded by the secretary that I hadn't gotten out the previous month's report. This simple device transformed a chore into a job that was a pleasure.

If you don't like the work in the first place and can't learn to like it, it seems to me that the best way out is to change jobs. There is no disgrace in such a move. Yet, I would not recommend doing it too frequently.

Changing jobs within an industry is a common occurrence today. If a man is dissatisfied with his job for some reason he should go to his superior and tell him so. Between the two of them, perhaps, a change profitable to both sides can be worked out. To like your work is a necessity. That way you will be happy, do better work, be a good companion to your co-workers, and, I have no doubt, that you will live longer. I do not mean to leave the impression that if you are in the kind of work you like everything is rosy. There are always difficult spots in any position, but they are made more bearable when you like your work.

### Be Active in Technical Societies

This aspect of creating your opportunities includes reading the literature published by the societies and being an active member of these groups. In a way such activity is a bit of dual advertising. Your name and company affiliation go together. Your company becomes better-known through your activity and is looked upon with favor because it supports the society. You become better-known in your company through the good work that you do in the society by holding office and presenting papers at the society's technical sessions. Lack of such activity may stall your opportunities. Let me give you an example.

Recently, there was an important opening in a large industrial organization. Various men were being discussed for this position. One man, who had the technical ability to do the job, was openly discussed in this manner. "No, he is not the man for the job. This is a big company. Who ever heard of him? He doesn't belong to any technical societies, nor has he ever given a paper before a technical society. He is an unknown." It was on this basis that an adverse opinion of this man was fostered. His promotion had hinged on active participation in technical societies.

### Have an Outside Interest, Perhaps Two

There are innumerable outside interests and all are absorbing. One man who has reached a good height in Norton Company is Herbert Wagner, an internationally famous photographer. Another, Alexander Beebee, is an expert archer. He makes his own arrows and does a beautiful job. Two other men high up in our company are painters of some note. One of my best friends is an authority on Lincoln and currently is collecting material not only on Lincoln but also on Lincoln's contemporaries. He is in great demand as a guest speaker. Why should you have an outside interest? The answer is, to make you a more interesting person. You will become a conversationalist on topics other than your own work. You will not be considered a dumbbell by members in your company organization. You will be tagged as being a broader individual and it will tend to influence your opportunities.

### Take Part in Home Life

The wife has problems around the house. Take a part in them. A happy home life leads to contentment which in turn helps materially toward a successful business career. The wife cannot do your work for you but she can help by being congenial to your associates and by being an inspiration. These characteristics come more easily when the home life is happy and contented. Married life is a two-way affair.

I know of two people who have not progressed very far in a particular oganization, although they had the opportunity. These two men were sent to different parts of the country to work in the sales department. Because the wife was unhappy in her new location, in each case, failure on the part of the husband to help solve the little daily household problems led to his downfall. They are back with the parent office and have only fair, mediocre jobs.

### Have a Part in Community Life

More and more, industry is recognizing its responsibility to the community in which it is located. My company supports a Junior baseball team, contributes heavily to the Community Chest, the Red Cross, and to the erection of hospitals, schools, and churches. One of our vice-presidents spends half of his time as Mayor of the City of Worcester. Other people in the company have city offices such as councilmen and school committeemen. These civic activities must be engineered and prosecuted by people without pay. There is a tendency to "let George do it." Who can do it better than an engineer? Even though there are knocks to be received and plenty of criti-

[1] Quality Control Consultant, Norton Company, Worcester, Mass.

cism, somebody has to do it. Your company will appreciate your service on civic jobs.

One of the great troubles with our government today is that it is run by incompetent people. Community life, however, need not be political. Participation in this work will make you better acquainted with basic social and economic problems. You will improve your knowledge of human relations and in turn will develop greater skill in working with people.

### A Belief in a Higher Authority

I recently read about the mysteries of pollination of flowers, how bees have a sense to keep to the same kind of flowers while collecting honey on any one trip even though flowers with similar colors are nearby. Pollination of flowers by bees, reproduction itself, the order of the universe, our physical make-up of brains, reflexes, natural laws, all suggest a supreme master. These laws which we use every day, unconsciously, demand our respect. Einstein is reported to have said, "We never subdue nature. We always submit to the laws of nature." It is no disgrace to believe in a Supreme Being. Such a belief will add to your stature.

Aside from these six main essentials in creating one's opportunities, there are a multitude of minor ones. Many of them are obvious. Some principally apply at times when it is in order to seek a new location. Others, such as cleanliness, clothes, courteousness, and so on, apply at all times.

We should cultivate means to appreciate good qualities in others, avoid impatience, and not harbor grudges. Consider the feelings of others and give credit where credit is due. Always be fair and square. Don't be sour: humor can lick many problems. Be cordial when greeting people and give the other guy the benefit of the doubt.

Perhaps all these rules only add up to being a gentleman. I find that people will subconsciously react favorably to you if you love your work. You will not need to remember rules on how to act in certain circumstances. The action will be spontaneous.

### 1954 Society Records Sent Upon Request

MEMBERS of The American Society of Mechanical Engineers who wish to receive copies of the 1954 issue of Personnel of Council, Boards, and Committees With Other ASME Records (AC-10) or Certificate of Incorporation, Constitution, By-Laws, and Rules (MM-1) should address their requests to the Secretary, ASME, 29 West 39th Street, New York 18, N. Y.

# Actions of the ASME Executive Committee

## At a Meeting at Headquarters, Jan. 20, 1954

A MEETING of the Executive Committee of the Council was held in the rooms of the Society on Jan. 20, 1954. Lewis K. Sillcox, chairman, presided. In addition to Mr. Sillcox, there were present: Thompson Chandler, Harold E. Martin, Albert C. Pasini, and Willis F. Thompson of the Committee; Joseph L. Kopf, treasurer; Edgar J. Kates, assistant treasurer; V. Weaver Smith, chairman, Organization Committee; H. R. Kessler, vice-president; F. L. Bradley, Louis Polk, and R. B. Lea, directors at large; C. E. Davies, secretary; O. B. Schier, 2nd, assistant secretary; and Ernest Hartford, deputy secretary.

### Budget Revision

Upon recommendation of the Finance Committee, it was voted to authorize certain changes in income and expenditure in the 1953-1954 budget.

### Public-Relations Appropriation

The Finance Committee at its meeting on Jan. 18, 1954, in response to the recent request of the Executive Committee, voted an additional appropriation for Public Relations from the 1953-1954 budget.

### Revisions in Retirement Plan

The Committee reviewed the suggested revisions on the retirement plan for Society employees as submitted to Council on Nov. 29-30, 1953. It was voted to adopt certain changes in the retirement plan, and to empower the Pension Committee, with the advice of legal counsel, to make the necessary changes in the Rules and Regulations to cover the modifications in the retirement plan.

### Public Relations

As requested by the Committee on Dec. 28, 1953, Ketchum, MacLeod and Grove, Inc., submitted a statement of its intentions. This statement was circulated to the members of the Committee, which authorized the retention of the services of Ketchum, MacLeod and Grove, Inc., of Pittsburgh, Pa., for one year. The Secretary was requested to set up a procedure for controlling the production costs and to report periodically to the Council.

### Mexico Meeting

The Committee requested the President to designate members of the Council to represent it officially at the International Meeting of the Society to be held in Mexico, March 10-12, 1954.

### Pittsburgh Meeting

The Committee authorized the President to select the chairmen of Boards and Committees for whom a mileage allowance should be made for attendance at Council meetings during the ASME Semi-Annual Meeting, in Pittsburgh, Pa., June 20-24, 1954.

### Task Group

On Dec. 1, 1952, the Council authorized appointment of a Task Group, as a result of the recommendation of the Committee on Society Policy, "to undertake an immediate study of the possibilities of an active post-college training and orientation program in the communities where the younger engineers live, with particular view to stimulating their creative and leadership abilities."

The chairman of the Task Group reported that a questionnaire had been developed and sent to a sample group of 14 Sections in the eight Regions, and while it was an excellent way to determine why so many Junior Members have dropped out of the Society, the lack of response was discouraging. Upon recommendation of the vice-presidents, the Committee voted to discharge, with thanks and appreciation, the Task Group composed of G. H. Howell, chairman; D. J. Cronberger, J. J. Parthum, and T. E. Winkler.

### Christie Memorial Lectures

In recognition of Prof. A. G. Christie's contribution as representative of the Society on the Engineering Education Mission to Japan in 1952, the Japan Society of Mechanical Engineers established the "Christie Memorial Lectures." Report has been received that eight lectures have been delivered dealing particularly with steam engineering. The Committee voted to express to the Japan Society of Mechanical Engineers the appreciation of the Society for its splendid recognition of the attainments of Professor Christie by establishing these lectures.

### Certificates of Award

Certificates of Award were granted to the following retiring chairmen of Sections: Raymond F. Schierland, Cincinnati; Keith N. Newhouse, Nebraska; and T. J. Uhl, Jr., North Texas.

A certificate of Award was also granted to Joseph W. Barker, retiring chairman of the Meetings Committee.

### Fulton Monument

The Robert Fulton Monument, which was erected by the Society in Trinity Churchyard in 1901, is in bad condition and the Office of the Corporation of Trinity Church has suggested that the ASME may like to have it put back in good condition. The Committee authorized an appropriation to recondition the monument.

### EUSEC

The Council voted to accept the recommendations and resolutions of the Paris meeting of the Conference of Representatives From Engineering Societies of Western Europe and

the United States (EUSEC), Sept. 7–11, 1953. (See pp. 214–215, February, 1954, MECHANICAL ENGINEERING.)

### Meeting With ASME Representatives

The Committee scheduled its customary annual meeting with ASME representatives on United Engineering Trustees, Inc., The Engineering Foundation, and the Library Board, to discuss the problems of these bodies. This year's meeting was a dinner meeting and was scheduled for February 18.

## Engineering Societies Personnel Service, Inc.

THESE items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members, or nonmembers and is operated on a nonprofit basis.

In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office.

When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

| New York | Chicago | Detroit | San Francisco |
|---|---|---|---|
| 8 West 40th St. | 84 East Randolph St. | 100 Farnsworth Ave. | 57 Post St. |

### Men Available[1]

**Mechanical Engineer,** 42, married, civilian experience, eight years design of naval fire-control equipment; military experience, two and one-half years product design and development officer with Research and Development Service, Fire Control Section, Office Chief of Ordnance, Washington, D. C.; three years Operations Officer heavy-automotive maintenance installation; three years development, proof experience on Army fire control, including electronics equipment, Aberdeen Proving Ground, Md. Presently a Major, Ordnance Corps, U. S. Army. Desires position in product design and development or managerial fields. Location, open. Me-58.

**Management Engineer,** 24 years of industrial-engineering and management experience. Includes supervision, cost control, rate structure, incentives in metal, glass, mining, and copper chemicals. Desires larger responsibilities. Me-59.

**Mechanical Engineer,** 39, BSME, executive background, 18 years' wide experience design of special machinery, automotive, tractor, hydraulics, rubber, production equipment, as design engineer and consultant. Responsible administrator. Registered Ill., Colo., Texas, Ga., Okla. Who's Who Commerce and Industry. ASME, SAE. Me-60-809-Chicago.

**Mechanical Engineer,** 39, BME, PE Conn., 18 years' experience in design of machine tools. Thorough knowledge of materials, scheduling, production, and purchasing. Desires permanent supervisory position leading ultimately to chief engineer. Me-61.

**Materials and Equipment Engineer,** mechanical, 37, family; petroleum or heavy-equipment industries; construction experience, piping, and structures; familiar with standards, materials, and quality control. Will relocate. Me-62.

**Mechanical Engineer,** 29, married, nine years machine-shop, machine-design, plant engineering. Supervisory capacity as chief designer, assist chief engineer. Desires position of responsibility and opportunity. New England, Pacific Northwest. Me-63.

**Mechanical Engineer,** 37, married, 15 years' experience centrifugal pumps. Design, fabrication, and testing. Also extensive sales and application-engineer experience. Will locate anywhere. Me-64.

**Mechanical Engineer,** 28, married, BS, eight years' experience, including operation and maintenance diesels, steam plants, refrigeration equipment, pumps. Competent electric-power field, both practical and basic theory. Desires work with good chance for promotion or profit sharing. Capable taking charge field project. Will travel. Speaks and writes Spanish well. Me-65.

[1] All men listed hold some form of ASME membership.

### Positions Available

**Mechanical Engineer,** over 35, tank and equipment-estimating and installation experience covering lead-lined, rubber-coated, and corrosion-resistant piping, tanks, etc., for office work with contractor. Retired plant or construction engineer considered. $5000–$6000. Northern N. J. Y-9574.

**Product Engineer,** 25–35, ME graduate, manufacturing experience, for product design and development involving direct contact with customers, production departments, and research laboratories in technical and industrial-glassware fields, covering piping, pumps, and textile equipment. $5000–$6000. Western N. Y. Y-9622.

**Administrative Sales Engineer,** 32–38, mechanical, electrical, or administrative-engineering graduate, minimum of ten years' experience in electrical, mechanical, machine, or metal-manufacturing industry, producing industrial products. Must have background in sales engineering, sales administration, estimating bid prices. Background in government-contract acquisition, sales forecasting, product pricing, contract negotiation desirable. $9000–$10,000. Conn. Y-9625.

**Department Head,** ME degree and experience in heavy-industrial maintenance, to head up plant-engineering department. $8000–$10,000. Pa. Y-9651(*a*).

**Junior Industrial Engineer,** 22–30, BS (IE), ME, or ChE, one year's experience in time and motion study, plant layout, and work simplification. Practical experience in manufacturing techniques helpful. Will establish manufacturing methods and develop incentive standards; conduct special methods and layout studies on plant operations. Carry on special manufacturing-costs studies with guidance of the industrial engineer. Salary open. N. J. Y-9658.

**Engineers.** (*a*) Industrial-design engineer, minimum of five years' experience in industrial-design work. Will head up a new industrial-design division for middle-sized construction firm. Will supervise staff of draftsmen, detailers, etc., as required. Must be able to travel. Salary open. (*b*) Assistant chief engineer, about 40, minimum of six years' construction engineering and estimating, to understudy present chief engineer. Must be able to approach customers. Salary open. Southwest. Y-9659.

**Machine-Shop Supervisor,** thorough knowledge of machine-shop management and production and capable of supervising and assuming complete responsibility for a small experimental machine-shop operation. Some engineering background preferred. Salary open. N. J. Y-9661.

**Industrial Engineer,** 35–45, industrial or ME graduate, cost accounting, financial analysis, and budgetary-control experience for consulting firm. $8000–$10,000. Considerable traveling. New York, N. Y. Y-9663.

**Administrative Engineer,** mechanical graduate, 35–45, ten years' manufacturing experience on mass-production items such as engines, pumps, etc. Good knowledge of tooling and some knowledge of commercial end of the business. Some traveling between plants in the East. $12,000–$15,000. Headquarters, New York, N. Y. Y-9665.

**Chief Engineer,** executive, heavy administrative background in industry, thorough knowledge of financial aspects of an industrial plant employing over 1000 people, and heavy mechanical or electrical-engineering background with ability to set up, correlate, and organize an engineering department. About $12,000. N. J. Y-9667.

**Engineers.** (*a*) Chief product engineer, seven to ten years' motor-design experience in the integral hp or large ac-dc motor field, and administrative abilities to supervise a design-engineering group of about 25 persons, working on medium and large a-c and d-c motors, generators, and related controls. Company manufactures special-purpose integral hp motors. (*b*) Gearmotor engineer, senior mechanical engineer, at least five years' experience in the design and manufacture of gearing, both spur and worm types. Will supervise design and be consulted on manufacturing. Experience in the motor-reducer field desirable. Salaries open. Midwest. Y-9678.

**Plant Engineer,** mechanical graduate, 26–33, several years' experience in machine-shop practice. Position will eventually lead to plant manager. $6000 to start. Northern N. J. Y-9680.

**Engineers** for research, design, and development on aeronautics, guided missiles, and jet aircraft. (*a*) Jet power-plant engineer, four to six years' experience. $6600–$8400. (*b*) Air-conditioning engineer, two to six years' experience. $4620–$8400. (*c*) Aerodynamics engineer, one to five years' experience. $4620–$8400. (*d*) Structures engineer, aeronautical, civil, or mechanical degree, for aircraft, guided missiles, and rockets. $4620–$7440. (*e*) Material and process engineer, five to six years' experience. $5220–$6600. (*f*) Structural plastics engineer, six to eight years' experience. $6600–$8400. (*g*) Aircraft-controls engineer, eight years' experience. $7440–$9480. (*h*) Armament engineer, two to four years' experience. $6600–$8400. (*i*) Supervisor, antenna engineers, seven to ten years' experience. $8400–$10,680. (*j*) Supervisor, electronics-circuit engineers, seven to ten years' experience. $8400–$10,680. (*k*) Supervisor, electronic-systems engineering, seven to ten years' experience. Salary open. (*l*) Resistance-welding engineer, five to ten years' experience. $6600–$8400. Must be U. S. citizens. East. Y-9682.

**Research Engineer,** mechanical graduate, seven years' experience in basic research and evaluation on blowers, pumps, timers, fluid flow, valve design. Some training or experience in thermodynamics. $6500–$7200. Northern N. J. Y-9686.

**Chief Draftsman,** mechanical or electrical engineering training and at least five years' experience as chief or assistant chief draftsman of instrument or electronic-manufacturing company. $8000–$10,000. Long Island, N. Y. Y-9689.

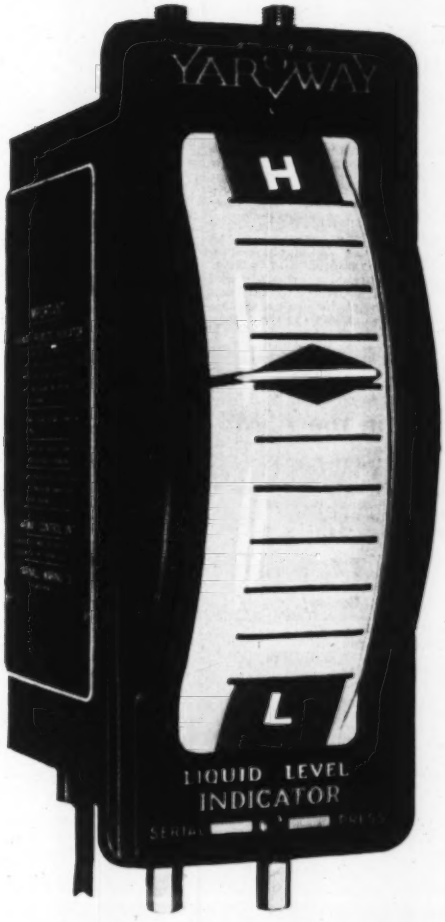
**Sales Engineer,** 25–35, industrial-sales experience, preferably with mechanical or electrical degree. Company manufactures carbon products, including carbon brushes for electric motors and generators, and mechanical-carbon parts used such as bearings, pump seals, vanes, etc. Will represent company to power and light companies, railroads, and industrial plants. $6000, plus bonus to start. Pittsburgh, Pa., Cincinnati, Ohio, and St. Louis, Mo. Y-9692.

**Sales Engineer,** preferably mechanical, 35–45, executive-sales type, for the sale of printing presses. Must have had some experience in this line. Also some design experience on printing presses. $8000, plus commission; fringe benefits. Company will pay moving expenses. Territory, South and Southwest. Y-9694.

**Maintenance Engineer,** up to 45, engineering degree, at least three years' experience in maintenance and repair of heavy equipment. Knowledge of chemical or mining operations. Will do maintenance and repair of heavy equipment for a chemical and mining company. $6000–$8000. Fla. C-1595(*c*).

**Engineers.** (*a*) Process engineer, mechanical or industrial graduate, five years' experience in

(*ASME News continued on page 312*)

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A new "wide vision" face on Yarway Remote Liquid Level Indicators allows reading from the side as well as front of the indicator. Boiler water levels and other liquid levels can be checked from most any position.

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Over 10,000 are used throughout industry for boiler water and other liquid level indication . . . and for superheater pressure differential indication aboard ship.

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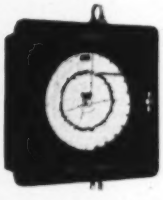
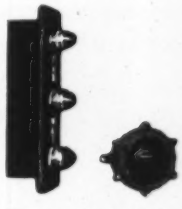


■ Yarway Hi-Lo-Graph Recorder provides not only water level indication, but also a 24-hour recording of water levels. See Yarway Bulletin WG-1830.



■ Yarway Remote Hi-Lo-Alarm Signals—lights or horns—can be placed at any location in plant. See Yarway Bulletin WG-1823.

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engineering field, some of which should be in precision manufacturing. Will determine sequence of operations to process and assemble precision parts; co-ordinate installations of approved changes and design methods, specifications, and routing for a manufacturer of fuses, watches. $5740–$8320. Employer will negotiate placement fee. (*c*) Project engineer and estimator, graduate, seven or eight years' estimating product and process engineering in precision manufacturing. Knowledge of estimating project costs. Will determine total labor, tooling, equipment costs necessary for completion of project from set of blueprints and prepare final bid on all compiled data for afore-mentioned manufacturer. $7000–$8000. (*d*) Chief tooling engineer, graduate, eight to ten years' tool and equipment-design work, some of which should be in supervisory capacity. Knowledge of tool and equipment design. Will supervise tool and equipment-design section for afore-mentioned manufacturer. About $10,000. Employer will negotiate placement fee. (*e*) Tooling engineer, graduate, six to eight years' experience on precision tools and machines. Will analyze and plan design of tools, dies, and equipment, also determine feasibility of other designers' work. $7500–$9000. Employer will negotiate placement fee. Ohio. C-1604.

**Maintenance Engineer,** over 40, at least five years' experience in maintenance of rubber or textile-fabricating machinery. Will do maintenance work on heavy-plant equipment for a felt manufacturer. Up to $9000. Employer will pay fee. Ill. C-1619.

**Supervising Project Engineer,** mechanical, at least three years' experience in machine-shop tooling and preferably in pumps and valves. Supervisory ability. Will organize, schedule, and direct all engineering work necessary for custom-built pumps, valves, and hydraulic equipment, for a manufacturer of pumps. $6600–$9000. Employer will pay fee. Ill. C-1626(*c*).

# Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after March 25, 1954, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

## Key to Abbreviations

R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member

## New Applications

*For Member, Associate Member, or Affiliate*

ALFORD, LYNN O., JR., Columbus, Ohio
ANDERSON, ROY A., Houston, Texas
ANDREWS, DONALD E., Edgewood, R. I.
ANDREWS, HARDAGE L., Bridgeport, Conn.
ANTOS, VICTOR, North Bergen, N. J.
ARCHIBALD, PAUL A., Burnham, Pa.
BABAR, ABDUR R., W. Punjab, Pakistan
BADGETT, STEPHEN H., Cincinnati, Ohio
BAIRD, ROBERT D., Wauwatosa, Wis.
BALL, JAY J., Detroit, Mich.
BANDOMER, RUSSELL W., Sharonville, Ohio
BHADRASIRI, SATHIEN, Bangkok, Thailand
BISHOP, MARSHALL E., Poughkeepsie, N. Y.
BOWERS, JOHN F., Clifton Heights, Pa.
BRANDISH, JOHN P., Milwaukee, Wis.
BRANSON, J. THOMAS, Philadelphia, Pa.
BROWN, ROBERT M., Alliance, Ohio
BULLER, FRANCIS H., Schenectady, N. Y.
CARLSON, JOHAN A., Wallingford, Pa.
CASSIDY, PAUL, St. Louis, Mo.
CAWLEY, WILLIAM E., Richland, Wash.
CHANDLER, JACK, Endicott, N. Y.
CHEN, SIMON K., Maywood, Ill.
CHITWOOD, HAROLD D., Wichita, Kan.
CHRISTENSEN, HARLAND R., Charlotte, N. C.
CHRISTMAN, JAMES R., Massillon, Ohio
CLARK, PAUL R., Dhahran, Saudi Arabia
CLARKE, ARTHUR E., Burbank, Calif.
CLEM, DONALD V., Birdsboro, Pa.
CLOTHIER, ROBERT F., Auburn, Ala.
COLIMITRA, THOMAS A., Bridgeport, Conn.
COLLEY, TOM C., Los Angeles, Calif.
COLOCOUSIS, JOHN, Philadelphia, Pa.
COMPTON, JOE E., Houston, Texas
COOLEY, EARL T., Rochester, N. Y.
COON, THOMAS E., Birmingham, Mich.
COOPERMAN, WILLIAM, New York, N. Y.
COVINGTON, PERRY C., Birmingham, Ala.
CRIDER, HAROLD E., Mobile, Ala.
CROY, ROBERT J., Paducah, Ky.
DESSART, VICTOR J. A., Mons, Belgium
DETAMORE, ROBERT M., Culpeper, Va.
DICKEY, DICK, Kansas City, Mo.
DIETRICK, CHARLES R., Fanwood, N. J.
DOLE, RICHARD W., New York, N. Y.
DOTTERY, ROBERT T., San Francisco, Calif.
EDERER, RALPH, Saginaw, Mich.
EHRENFEST, PAUL, Cleveland, Ohio
EICHORN, ROGER H., Trenton, N. J.
EINBECKER, THOMAS J., Homewood, Ill.
FARRINGTON, CECIL G., JR., Houston, Texas
FEEHAN, JOHN D., Detroit, Mich.
FISHER, HOWARD M., Akron, Ohio
FITZGERALD, PAUL F., Charleston, S. C.
FOGGO, JAMES, Los Angeles, Calif.
FRANCE, A. WARD, Wyancote, Pa.
FRITZ, EMANUEL, Berkeley, Calif.
GALLACHER, THOMAS J., Brooklyn, N. Y.
GASKIN, HENRY G., Beloit, Wis.
GAYSOWSKI, JOSEPH, JR., Chicago, Ill.
GIROUX, EDWARD J., La Crosse, Wis.
GORZEGNO, WALTER P., Bronx, N. Y.
GRAHAM, CHARLES S., Cedar Grove, N. J.
GUM, WILLIAM B., St. Albans, W. Va.
HAAKE, CHARLES R., La Grange, Ill.
HALL, JOHN F., South Charleston, W. Va.
HANDER, EDWIN J., Westwood, N. J.
HART, RAYMOND, Finchley, England
HOLMES, ARTHUR D., Tullahoma, Tenn.
HOMAN, WILLIAM R., Chicago, Ill.
JOHNSON, BERNARD A., Skokie, Ill.
JOHNSON, CLARENCE, South Euclid, Ohio
JONES, ARTHUR D., Tampa, Fla.
JONES, DOUGLAS M., Los Angeles, Calif.
KANE, FRANK J., Staten Island, N. Y.
KESTNER, HAROLD R., South Euclid, Ohio
KIRK, HUGH A., Toledo, Ohio
KOEPF, ALMONT H., Seattle, Wash.
KROFT, ALBERT M. K., Baltimore, Md.
LACZ, JOHN A., Paterson, N. J.
LINEBERRY, CLAUDE S., Windsor, Conn.
LLOYD, EDWARD C., Washington, D. C.
LUBOYESKI, STANLEY R., Bristol, Conn.
MACISAAC, JOHN T., JR., Spray, N. C.
MACLEAN, JAMES B., Garden City, N. Y.
MACMILLAN, ROBERT H., Cambridge, England
MANGIAROTTY, RUDOLPH A., Montreal, P. Q., Can.
MCAVOY, JACK S., Ajax, Ont., Can.
MCCORMICK, RICHARD, Oswego, N. Y.
MCKINNEY, DAVID H., Houston, Texas
MCNERNEY, JOHN J., Los Angeles, Calif.
MCNICHOLS, HAL B., Columbus, Ohio
MEIJER, JOHAN M., Colombo, Ceylon
MELVILLE, JOHN D., Waterbury, Conn.
METCALFE, ROBERT P., Lake Jackson, Texas
MILLER, ARTHUR J., Jeannette, Pa.
MOISE, JOHN C., East Hartford, Conn.
MOKHLESS, GHULAM H., Abadan, Iran
MULROONEY, JOSEPH P., Louisville, Ky.
MUTZ, EMIL F., Union, N. J.
NEWMAN, ARTHUR C., Toronto, Ont., Can.
NEWMAN, ROBERT C., Berkeley, Calif.
NOEL, LOUIS E., St. Louis, Mo.
NORELL, JACQUES J., Friant, Calif.
NOYES, ROBERT N., Chagrin Falls, Ohio
O'NEILL, JAMES K., Hartford, Conn.
OSUCH, LEONARD J., Chicago, Ill.
PARKER, GEORGE M., Drexel Hill, Pa.
POOR, WILLIAM R., Birmingham, Ala.
PRELL, EDWARD G., JR., Lakewood, Ohio
PROCTOR, JOSEPH H., Coatesville, Pa.
PUGEL, JAMES D., Seattle, Wash.
QUIGGIN, FRANK W., Mt. Vernon, Ohio
REED, EUGENE L., Richland, Wash.
RICHARDSON, ROBERT S., Upper Montclair, N. J.
ROLLINS, JAMES D., Pittsburgh, Pa.
ROSENTHAL, FELIX, Chicago, Ill.
RUDGINSKY, SAMUEL, Boston, Mass.
SCHAEFFER, HARRY H., Dearborn, Mich.
SCHLAGEL, WALTER J., Ames, Iowa
SCHMERZLER, LAWRENCE J., Bloomfield, N. J.
SCHULER, ALBERT E., Huntsville, Ala.
SCHULZ, THEODORE R., Williamsville, N. Y.
SHAW, GEORGE I., Brooklyn, N. Y.
SHIFLETT, WENDELL P., Kingsville, Texas
SIEGEL, ROBERT, Schenectady, N. Y.
SILVESTRE, LOUIS A., New York, N. Y.
SIMS, BERNICE O., JR., Birmingham, Ala.
SKINNER, HORACE M., Hopatcong, N. J.
SMITH, JOHN H., Montreal, P. Q., Can.
SMITH, WINSTON O., Norman, Okla.
SONDERLING, HANS H., North Hollywood, Calif.
STONEHILL, LLOYD H., Shreveport, La.
STRONG, ROBERT G., Chicago, Ill.
SUNDARARAJAN, VANKEEPURAM, Ambur, India
SWIGART, ORAL R., State College, Pa.
TEK, MEHMET R., Bartlesville, Okla.
THOMAS, CLARENCE, Birmingham, Ala.
THORSON, WARREN K., Whittier, Calif.
TOVAR-CORDOVA, CARLOS, Mexico, D. F., Mex.
TURK, JOHN W., JR., Longview, Texas
TURNER, CHARLES G., Levis, P. Q., Can.
VAN DER TAS, LEENDERT, Amsterdam, The Netherlands
VAN NOTE, W. G., Potsdam, N. Y.
VEERAKONE, V. D., Jaffna, Ceylon
VELTROP, JAN A., Baton Rouge, La.
VOORHEES, HOWARD R., Ann Arbor, Mich.
WAALKES, DONALD J., Milwaukee, Wis.
WEIGAND, CHARLES G., Chicago, Ill.
WEINIG, FRIEDRICH S., Blue Ash, Ohio
WHITE, LAWRENCE E., Oreland, Pa.
WHITE, PAUL G., Birmingham, Ala.
WITTIG, HERMAN H., Milmont Park, Pa.
WOODHOUSE, ALBERT F., Chicago, Ill.
WREN, CLIFTON J., Cincinnati, Ohio

## Change in Grading

*Transfers to Member, Associate Member, or Affiliate*

BROWN, RICHARD G., Phillipsburg, N. J.
CALDWELL, KENNETH S., West Covina, Calif.
CLEMENS, JOSEPH D., Wilmington, Del.
CROFT, JACOB C., JR., Johnson City, N. Y.
DUNCAN, DONALD S., Brooklyn, N. Y.
GIESE, CARL A., JR., New Martinsville, W. Va.
GMITRO, ARTHUR F., Chicago, Ill.
HOLM, JORGEN, Englewood, N. J.
MILLER, ROBERT O., Cincinnati, Ohio
MOCHEL, JOHN B., Philadelphia, Pa.
MUNDY, JAMES T., Atlanta, Ga.
REITZ, WILLIAM, Paducah, Ky.
RICE, CLYDE M., Montclair, N. J.
ROTHEMICH, EDMUND F., Worcester, Mass.
WANDYES, FRANK J., Hamden, Conn.

*Transfers from Student Member to Associate Member* ..... 50

# Obituaries . . .

**Vasile Constantinescu** (1880–1953), mechanical and marine engineer, proprietor, Union Machinery Repair Shop, Lethbridge, Alta., Can., died Oct. 11, 1953. Born, Galatz, Romania, July 7, 1880. Parents, Ion and Gherghina Constantinescu. Education, graduate, College V. Alexandri, Galatz, 1898; ME, Polytechnic Schools, Bucharest, 1902. Married Annie Hunt, 1910. Assoc Mem. ASME, 1924; Mem. ASME, 1935. Survived by wife, and a son, Clinton Constant, Lakeland, Fla.

**Clarence Arthur Eaton, Jr.** (1921–1953), assistant chief dispatcher, Magnolia Pipe Line Co., Dallas, Texas, was killed in an airplane crash Dec. 11, 1953. Born, Dallas, Texas, May 6, 1921. Parents, Clarence A. and Lela L. (Crofford) Eaton. Education BS(ME), Southern Methodist University, honor graduate, 1947. He was president, Sigma Tau, 1946–1947; member, Blue Key Men's Honorary Fraternity; president, Student Branch ASME at SMU, 1946–1947. Lieut Commander, U. S. Navy—lighter-than-air. Married Iola Ruth Calhoun, 1942. Jun. ASME, 1947. Survived by wife; two sons, Arthur R., Clarence C.; his parents; and a sister, Mrs. L. C. Brecht, Dallas, Texas.

**Volney Cecil Finch** (1892–1953), professor of mechanical engineering, Stanford University, and consulting engineer, died Nov. 9, 1953. Born, Smith River, Calif., Aug. 24, 1892. Parents, Daniel W. and Belle (Gray) Finch. Education, graduate, U. S. Naval Academy Post-Graduate School, 1926; MS, Massachusetts Institute of Technology, 1927. Married Frances Bennet Meyer, 1922. Mem. ASME, 1928. Author of several books on aviation, including "Airplane Designers Handbook," 1930; "Preparation for Aviation," 1931; "Aircraft Engines," with A. B. Domonoske, 1936; "Non-Rigid Airships," 1942; "Airship Rigging," 1943; "Pump Handbook," 1948; "Jet Propulsion—Turbojets," 1948; and "Jet Propulsion—Turboprops," 1950. He also contributed articles to scientific and technical journals.

**Gustaf Leonard Fisk** (1887–1953), internationally known engineer and inventor, died in Boston, Mass., Nov. 4, 1953. Born Uttersburg, Sweden, Jan. 16, 1887. Parents, Leonard and Lovisa (Brickman) Fisk. Education, ME, first honors, Örebro (Sweden) Technical College, 1905. Naturalized U. S. A. citizen, Pittsburgh, Pa., Sept. 25, 1925. Married Hazel May Studley, 1920. He invented the Fisk cooling bed and held

(*ASME News continued on page 314*)

# LORD MOUNTINGS *Protect Vital Parts* on EVERY TYPE of AIRCRAFT

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**DALLAS, TEXAS** 313 Fidelity Union Life Bldg. **PHILADELPHIA 7, PENNA.** 725 Widener Building

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numerous other patents pertaining to the steel industry; also wrote many technical papers covering his work. Survived by wife and son, Karl G.

**Callender Payssoux Hadden (1885–1953),** president, Standard Supply and Hardware Co., Inc., New Orleans, La., died Feb. 7, 1953. Born, Boerne, Texas, June 21, 1885. Parents, Robert G. and Leonora (Payssoux) Hadden. Education, BE, magna cum laude, Tulane University, 1905. Married Ethelyn Phelps Coco, 1922. Mem. ASME, 1921. Survived by wife and three sons, Callender F., Jr., Robert W., Richard I.

**Joseph P. Haslach (1881–1953),** design engineer, American Type Founders, Mt. Vernon, N. Y., died Oct. 13, 1953. Born, Brooklyn, N. Y., March 5, 1881. Parents, Joseph and Elizabeth Haslach. Education, classical and business studies, St. John's University; scientific and technical studies, Pratt Institute. Married Josephine Hess, 1908. Mem. ASME, 1940. Survived by wife.

**Henry August Kieselbach (1886–1953),** former insulation executive for the Johns-Manville Corp., died Dec. 1, 1953, in Montclair, N. J. Born, Brooklyn, N. Y., March 14, 1886. Parents, Henry C. and Anna L. (Apel) Kieselbach. Education, ME, Stevens Institute of Technology, 1909. Married Olga M. Weisker, 1911; children, Marjorie, Richard, Virginia. Jun. ASME, 1914; Mem. ASME, 1929.

## Keep Your ASME Records Up to Date

ASME Secretary's office in New York depends on a master membership file to maintain contact with individual members. This file is referred to dozens of times every day as a source of information important to the Society and to the members involved. All other Society records and files are kept up to date by incorporating in them changes made in the master file.

From the master file are made the lists of members registered in the Professional Divisions. Many Divisions issue newsletters, notices of meetings, and other materials of specific interest to persons registered in these Divisions. If you wish to receive such information, you should be registered in the Divisions (no more than three) in which you are interested. Your membership card bears key letters opposite your address which indicate the Divisions in which you are registered. Consult the form on this page for the meaning of the letters. If you wish to change the Divisions in which you are registered, please notify the Secretary's office.

It is important to you and to the Society to be sure that your latest mailing address, business connection, and Professional Divisions' enrollment are correct. Please check whether you wish mail sent to home or office address.

For your convenience a form for reporting this information is printed on this page. Please use it to keep the master file up to date.

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Nature of work done.....

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☐ B—Applied Mechanics
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☐ G—Safety
☐ H—Hydraulics
☐ J—Metals Engineering
☐ K—Heat Transfer
☐ L—Process Industries
☐ M—Production Engineering
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☐ Y—Rubber & Plastics
☐ Z—Instruments and Regulators

*(Processing of address changes requires seven weeks)*

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**John Malcolm Owen (1895–1953),** mechanical engineer, Corning Glass Works, died Oct. 31, 1953. Born, Markleton, Pa., July 26, 1895. Education, graduate, Niagara Falls (N. Y.) High School, 1914; 3 years, Mechanics Institute, Rochester, N. Y. Mem. ASME, 1945. Survived by wife.

**Elbridge Woodman Palmer (1886–1953),** president, Kingsport Press, Inc., Kingsport, Tenn., died Nov. 18, 1953. Born Meredith, N. H., Dec. 4, 1886. Parents, Francis H. and Malina (Burt) Palmer. Education, high-school graduate, Norwood, Mass. 1905; Burdette Business College, Boston, Mass., 1907. Married Lillian Alice Weymouth, 1912; two sons, Weymouth W., Elbridge W. (deceased). Assoc. ASME, 1927. He was active in many civic and professional organizations. During World War II he was deputy director, printing and publishing division, War Production Board, 1941–1943; later held other executive posts in the Government. He was associate editor Merriam-Webster Dictionary; contributor, Encyclopedia Britannica, Collier's, and several others.

**Nils Oscar Smith-Petersen (1885–1953),** designing and consulting engineer, Walworth Co., New York, N. Y., died Dec. 22, 1953. Born, Grimstad, Norway, Jan. 10, 1885. Education, ME, Oslo Technical College, 1904. Naturalized U. S. citizen, 1912. Mem. ASME, 1946. He was active on several subcommittees of the ASME Boiler Code Committee. Survived by wife, Olga Baughman Smith-Petersen; a son, Nils M.; a daughter, Mrs. Thomas T. Acheson; and a brother, Frederick U.

**Robert Sedgwick Stangland (1881–1953),** chief engineer, By-Products Recoveries, Inc., New York, N. Y., died Dec. 15, 1953. Born, Kendall, N. Y., Oct. 5, 1881. Parents, B. F. and Emily S. (Bridgeman) Stangland. Education, ME, Columbia University, 1904; postgraduate work, 1905. Married Susie Bryant, 1917. Mem. ASME, 1916.

**Frank H. Stansfield (1884–1953?),** sales manager, Bridgeport (Conn.) Sawdust and Shaving Co., died some time ago, according to a report received by the Society. Born, Poughkeepsie, N. Y., June 30, 1884. Education, mechanical-drawing course, ICS. Assoc-Mem. ASME, 1916; Mem. ASME, 1935.

**Henry Stockmann (1897–1953),** senior design engineer, The Stearns-Roger Manufacturing Co., Denver, Colo., died Feb. 17, 1953, at his home in Round Rock, Texas. Born, Chicago, Ill., Feb. 21, 1897. Education, studied at Lane & Schurt Technical School; extension work in mechanical and civil engineering, petroleum chemistry, and allied studies. Mem. ASME, 1947. Survived by wife.

**John Stewart Thomson (1874–1953),** owner, firm of J. Stewart Thomson, Newark, N. J., died Dec. 4, 1953. Born, Jersey City, N. J., March 16, 1874. Parents, John B. and Ellen (Stewart) Thomson. Education, attended Cooper Union and Pratt Institute. Married Lillie Carlisle Thomson, 1902 (died 1942). Jun. ASME, 1901. Survived by three children, John A., Royal Oak, Mich.; Mrs. Alfred K. Fricke and Mrs. Ernest W. Thomas, both of Montclair, N. J.; two sisters, Ellen S. and Ethel A.; six grandchildren; and three great-grandchildren.

**Charles Ludwig Wachs (1876–1953),** president, The E. H. Wachs Co., Chicago, Ill., died Dec. 25, 1953. Born, Chicago, Ill., Nov. 18, 1876. Parents, Edward H. and Christine F. (Rothfuss) Wachs. Education, machine-design course, Lewis Institute; special courses in steam-engine design with tutors; and d-c electrical machinery, Armour Institute of Technology. Married Charlotte A. Swain, 1905. Mem. ASME, 1918. He was best-known by the line of small steam engines for which the company was first established by his father and which he completely redesigned about 50 years ago, providing one of the earliest high-speed, completely enclosed, self-lubricating engines on the market. Since the steam engine has been largely superseded by central-station power, his efforts have been devoted to the design and construction of machines for special purposes in which his remarkable ingenuity found expression. At the time of his death he was engaged in subsidiary work relating to the utilization of nuclear energy for power purposes. Survived by wife; a son, Edward H.; and two daughters, Mrs. Walter Meyer, Mrs. Earl Schuster.

**Marney Den Willey (1895–1953),** chief engineer, J. Ray McDermott and Co., Inc., Harvey, La., died Nov. 28, 1953. His home was in New Orleans, La. Born, Davenport, Iowa, May 19, 1895. Education, BCE, State University of Iowa, 1916. Mem. ASME, 1952. Author of several papers published in professional and technical journals; and held U. S. Patents pertaining to marine engines and foundations.

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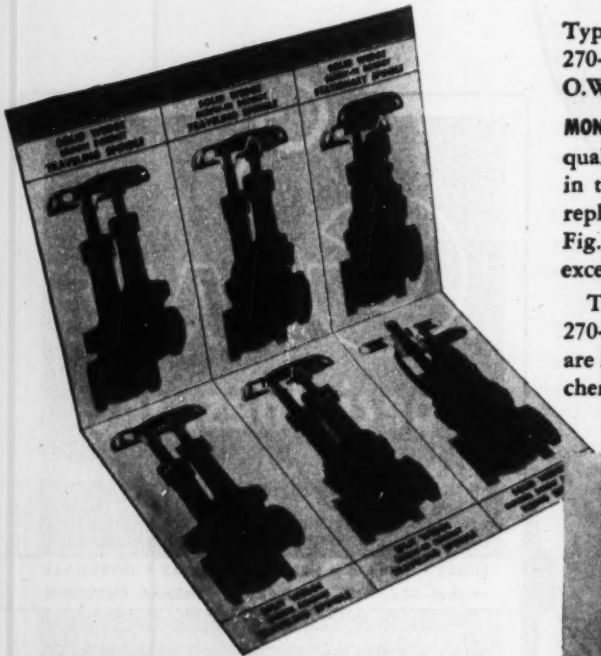
Look over any of the 35 patterns in your complete line of Bronze Gates. You'll find *savings* built into every valve. Jenkins valve specialists designed each one for easy maintenance and extra long wear. Try them on your toughest services and see why they take top-rating in any test for endurance and economy. Jenkins Bros., 100 Park Ave., New York 17.

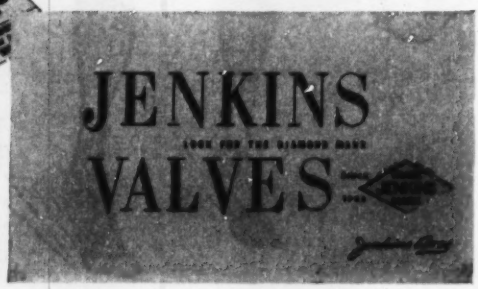
Typical of Jenkins design for built-in savings are the Fig. 270-U and Fig. 270-UN Gates for 200 lb. Steam, 400 lb. O.W.G. services.

**MONEL AND BRONZE SEATING COMBINATION** In Fig. 270-U a high quality bronze wedge seats against MONEL rings expanded in the body. The wedge takes the wear — it can easily be replaced when necessary by slipping a new one on the stem. Fig. 270-UN, with a nickel alloy wedge, is recommended for exceptionally severe conditions of rapid wear and corrosion.

These and other features of rugged construction make Figs. 270-U and 270-UN first choice for economy where conditions are most destructive to valves, as in oil refineries, dye houses, chemical, food, and rubber plants.



Jenkins Bronze Gate folder shows the many types available — lists convincing reasons why they are your best buy for any service. Ask for Form 181-A.

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**Available literature or information may be secured by writing direct to the manufacturer. Please mention MECHANICAL ENGINEERING**

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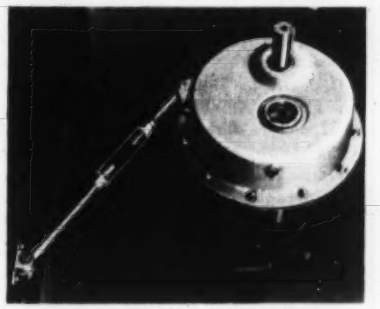


## New Shaft Mounted Drive

The Falk Corp. of Milwaukee, Wis., announces a new speed reducer which mounts directly on the shaft to be driven and requires no floor space other than that needed for the motor and tie rod connection. Easily adapted to fit various driven shaft diameters, this drive offers comparatively high ratios of speed reduction in very limited space. A choice of single or double reduction unit makes possible the selection of almost any output speed between 420 and 14 rpm, merely by changing sheave sizes within allowable limits. Six sizes to cover the range from $^1/_2$ to 30 hp. All-steel construction, highly efficient helical gearing, positive lubrication.

## New Lightweight Aluminum Industrial Roofing

In answer to the growing demand in industry for a maintenance-free metal roofing material of thinner gauge, Aluminum Co. of America is enlarging its line of industrial roofing materials with the addition of a new, lightweight corrugated aluminum sheet. Made of the same durable high-strength alloy as the standard .032 in. material, the new Alcoa Aluminum Corrugated Industrial Roofing and Siding product is only .024 in. thick.

The new .024 in. Alcoa Industrial Roofing sheet is supplied with corrugations $^7/_8$ in. deep and a 2.67 in. pitch identical to the .032 in. standard product. Design loads, and weight and coverage tables, are shown.

For information write to Aluminum Co. of America, 805 Alcoa Bldg., Pittsburgh 19, Pa.

## Cork Pipe Insulation

A new, unique design of cork pipe insulation that may be applied more rapidly and with substantial labor savings has been developed by the Armstrong Cork Co., Lancaster, Pa., for use on dual temperature lines where moderate service conditions prevail. Called LT-30 Cork Covering, the new insulation is applied by merely wrapping it around the pipe.

LT-30 is designed for use on air-conditioning systems and on chilled water and other cold lines where the liquid temperatures in the line are 30F or above, and relative humidity of the surrounding air does not exceed 70 per cent. On the hot water cycle, the new covering will withstand temperatures up to 200F.

## New Vibration Damper

The new Korfund VPS Elasto-Rib damper, a highly effective, inexpensive vibration-isolating material, can help manufacturers increase machine and worker productivity by allowing quick re-arrangement of production lines for new setups without the usual "downtime." This easy to install pad-type damper adds great mobility to heavy equipment by eliminating expensive bolting to floors, yet prevents machine "walking." It has a long useful life, does not pack down, and can be used over and over in new locations. Some typical applications of this versatile vibration isolating material include machine tools, punch presses, air conditioning equipment, engines and printing presses.

For more detailed information, write for Bulletin VPS, The Korfund Co., Inc. 48-35N 32nd Place, Long Island City 1, N. Y.

## Slot Wedges and Brush Tubes

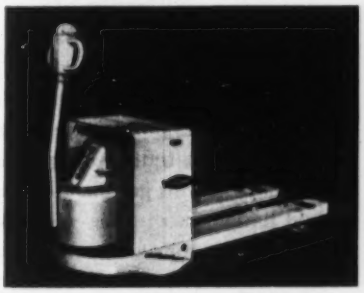
"Mycalex" glass-bonded mica motor slot wedges and insulated brush tubes offer outstanding mechanical and electrical advantages in the ability of "Mycalex" to withstand continuous operating temperatures to 650F. This high temperature endurance makes it possible to install it in critical insulating areas, i.e., slot wedges and brush tubes, with the result that higher temperature rise becomes permissible. Thus horsepower ratings at electric motors may be safely increased without increase in physical size. Conversely, a motor of specified horsepower can readily be redesigned to smaller dimensions.

The products are manufactured by Mycalex Corp. of America, Clifton Blvd., Clifton, N. J.

## Servo Pumps

A Vickers electro-hydraulic servo pump unit is essentially an electrically-controlled, variable-delivery, positive displacement, hydraulic pump. The combination of this pump and a rotary or linear hydraulic motor forms an electrically controlled hydraulic transmission, with the motor acting as the output member. These transmissions are usually designed especially for use in remote control operations and high-response servo systems employing electrical feedback.

Hydraulic servo pumps are described in a new Vickers brochure SE-15. Qualified technicians may secure booklet by writing Vickers, Inc., 1400 Oakman Blvd, Detroit 32, Mich.



## Powered Hand Trucks

The Clark Equipment Co., Buchanan, Mich., announces a complete new line of powered hand trucks for materials handling, designated the "Powrworker 26" line. Highlights of the "Powrworker 26" include a short overall length, maximum load stability, and several distinctive safety features.

The "Powrworker 26" has an overall length shorter than any other standard truck on the market, according to Clark. This was accomplished by reducing the maximum "lost length" to 26 in. This results in a truck only 26 in. longer than the length of the load which can be carried.

"Powrworker 26" chassis frames are fabricated from plate and bar steel, formed to shape and electrically welded into a unit structure, providing great strength and rigidity with minimum weight. Driving and hoisting motors are series wound, high torque type, ball bearing equipped, and horizontally mounted for maximum operating efficiency.

For complete information on the 1954 "Powrworker 26" line of trucks, write to the Clark Equipment Co., Industrial Truck Div., Powrworker Section, Battle Creek, Mich.

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When you use our functional spring hangers . . . which have the Blaw-Knox patented *internal swivel action* . . . and our vibration eliminators, you get custom-made results. And that holds good for rigid hanger assemblies and overhead roller assemblies.

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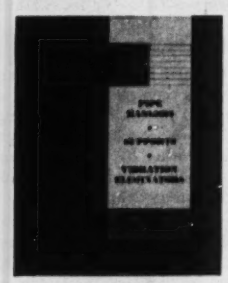

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Our engineers, who have solved many tough hanger and piping vibration problems, are always available to both design and make recommendations for your hanger requirements.

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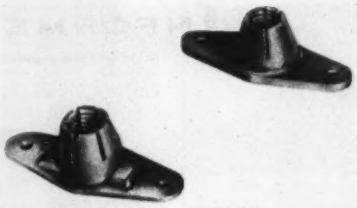

## Lighter High Temperature Weld Nut

A new lightweight, high-temperature, two-lug anchor lock nut has been developed by the Elastic Stop Nut Corp. of America, Union, N. J. The new lock nut is up to 45 per cent lighter than previous designs, easier to weld, and requires up to 75 per cent less critical material.

Designed for service up to 1200F, the new ESNA ZA1W1200 is available in 8-32, 10-32, and 1/4-28 thread sizes.

The ability of Type 347 to retain its elastic deflection characteristics at high temperatures gives these nuts re-usable locking properties. An ESNA-developed silver plating process is used on these nuts as a lubricant to prevent seizing and galling after high temperature service.

Since this special steel and silver plate is required only in the body of the nut, the new ZA1W1200 design has only the nut body made of the silver plated Type 347 stainless steel. The base plate which retains the nut and forms the lugs for welding or riveting is now made of Type 321 stainless steel. Base and nut body are supplied welded together into one unit, to facilitate on-the-job handling.

## Gasket Mounted Valve

A new gasket mounted, solenoid operated, four-way valve, that is fully shock resistant, has been developed by Rivett Lathe & Grinder, Inc., Boston, Mass. Impact and shock are eliminated by the use on the valve spool of a scalloped design, which opens or closes gradually increasing or decreasing areas to the ports as the spool is moved left or right.

Metering grooves built into the spool, plus a choke block assembly to control the speed of the spool, aid in allowing the flow to enter and leave the valve with an easier, smoother action; and permit use of the valve as a de-compression valve and a four-way valve in one.

The new Series 6600 valve is conservatively designed for 3000 psi oil hydraulic service and meets all JIC requirements. Two basic valves can be used for five sizes: by merely changing pipe tap size the 1 in. valve may be used for 1/2 in., 3/4 in. or 1 in. ips, and the 1 1/2 in. valve for 1 1/4 in. and 1-1/2 in.

For information write for Catalog 260, Rivett Lathe & Grinder, Inc., Brighton 35, Boston, Mass., mentioning this magazine.

Good engineering designs depend on low cost.

# SIMPLE DESIGN CHANGE TO STEEL CUTS COST FROM $1.15 TO 31¢

BEFORE any product design is accepted, the manufacturer asks, "Can it be built for less money?" Unless your designs pass this test they are likely to be rejected.

Knowing how to use welded steel gives you the advantage in developing any product for lowest cost manufacture. That's because steel is three times stronger than gray iron, two and one half times as rigid, and costs only a third as much per pound. Therefore, where stiffness or rigidity is a factor in a design, less than half the material is necessary.

Here, for example, is how one resourceful engineer put these qualities to work:

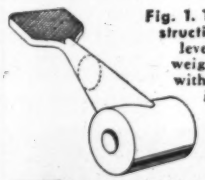

**Fig. 1. Traditional Construction.** Machine foot-lever, 10 inches long, weighs 6 pounds. Cost with broached keyway is $1.15.

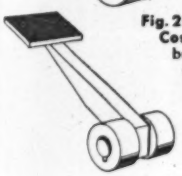

**Fig. 2. Simple Steel Design Costs 41% Less.** Can be built by the shop with only saw and shears. Weighs 2.7 pounds. Costs 68¢ complete with keyway.

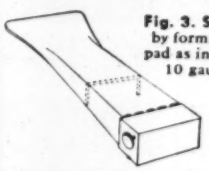

**Fig. 3. Saves 53% Cost** by forming lever arm and pad as integral piece from 10 gauge metal. Weighs 2.5 pounds. Costs 54¢.

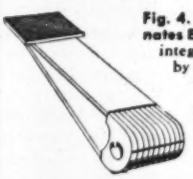

**Fig. 4. Saves 73%, Eliminates Broaching.** Hub with integral key is produced by stacking stampings in assembly. Arm is 10 gauge, brake formed and welded to hub. Cost is only 31¢. Weighs 2.2 pounds.

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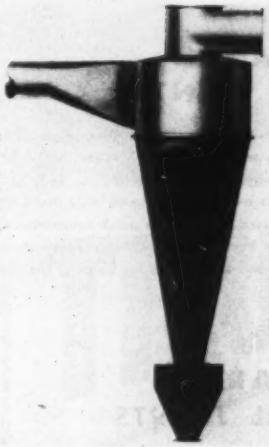

## Mechanical Dust Collector

A new mechanical dust collector, the Banister Dustmaster, announced by A. W. Banister Co., Inc., 23 Charles St., Cambridge 41, Mass., separates dust from air by means of centrifugal force. It has application in industrial plants for removing nuisance, toxic and hazardous dust . . . thereby reducing equipment maintenance, increasing productivity, improving product quality, maintaining a clean, healthful working atmosphere, and also for other purposes such as collecting valuable materials from dust, or as a precleaner for filters and electric precipitators.

Dustmaster is recommended for collecting and separating all manner of dry industrial dusts, when the gas temperature does not exceed 800 F, and when the shape and weight of the dust particles are such as to make mechanical separation practicable. For illustrated, 12-page Dustmaster Catalog, giving specifications, operating information, etc., write A. W. Banister Co.

## Electrostatic Air Cleaner

A new ceiling-suspended model of the home Precipitron electrostatic air cleaner has been announced by the Westinghouse Electric Corp. The average-sized home model, PH-122, is designed for simple installation in the main return air duct of a forced-air heating system.

Weighing only 200 lb (one-third less than its predecessor), model PH-122 fits the needs of the average five- to seven-room house. It handles from 1000 to 1200 cu ft of air per min. For larger homes, a slightly larger model, PH-242, is available, which handles from 2000 to 2400 cu ft of air per min. Both units clean recirculated air from the living quarters as well as "make-up" air from the outside.

For further information, write Westinghouse Electric Corp., Air Conditioning Div., Dept. T-556, 200 Readville St., Hyde Park, Boston 36, Mass.

This instructive and authoritative booklet will quickly prove itself indispensable wherever bending is done or is needed. It brings you a veritable gold mine of tested authentic bending methods applicable to any rotary type bender. The proper bending technique may frequently offer a new approach to an old problem by simplifying product design and cutting production costs.

The exact methods of producing various types of bends in a wide range of materials are illustrated, step by step, with over 90 diagrams and charts together with valuable tooling suggestions.

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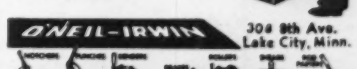

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for angular motion—

—also swivel motion

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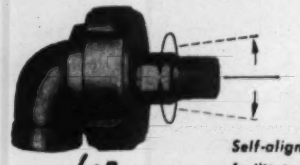

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Self-aligning! Exclusive side flexibility (up to 10°) speeds up and facilitates installation; prevents binding. Widely used for making compact, low torque swivel connections to reciprocating or rotating parts on platen presses, tire molds, die casting machines, oil burners. Easy to position piping accurately—no sagging, flopping lines. Leakproof, safe—pressure or vacuum. Ratings as high as 600°F., 3,000 psi (hydraulic). Sizes, ⅜" to 2"; angle or straight. Catalog No. 265.

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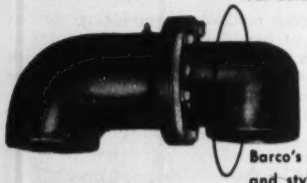
Superior design insures trouble-free performance, minimum roll drag, and up to 50% power savings. Inherent low torque is little affected by increasing pressure, speed, or temperature. Parts are easily accessible. Light running action minimizes wear, permits free-floating installations. No adjusting necessary—long, leakproof service. Ratings to 250 psi (steam); 450°F. Single flow or syphon styles. Sizes ½" to 2" and special to 5". Wide choice of models. For detailed information, ask for Catalog No. 300.



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Barco's new line of ball bearing Swing Joints is complete with sizes and styles to meet every requirement on loading racks, fueling assemblies, and chemical applications. "O" ring gives long life, leakproof seal. Full bearing surface, swiveling 360° in one plane (single swing) or in two planes (double swing), supports normal piping. Ball bearings can't fall out. Built in steel for pressures to as high as 1500 psi (hydraulic); temperatures, —40° to 225°F. 11 styles: straight, angle, double angle, counter balance. Sizes 2", 2½", 3", 4". Catalog No. 400.

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5210 Hough St., Barrington, Ill. (A Chicago Suburb)
In Canada: The Holden Co., Ltd.
The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Revolving Joints
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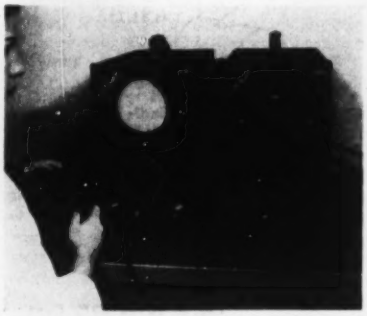
## Molded Nylon Caps for Electrodes

Caps of Du Pont nylon for reference electrodes are being molded and used by the Leeds and Northrup Co., Philadelphia, to improve performance of their industrial and laboratory pH measuring devices. Caps are made by E. I. du Pont de Nemours & Co., Wilmington, Del.

Tests conducted by Leeds and Northrup convinced them of nylon's strength, dimensional stability, and excellent electrical qualities. These, coupled with nylon's resistance to high temperatures and chemical attack, considerably lengthened the service life of flow-type and immersion-type electrodes. Such electrodes are used in Leeds and Northrup pH Speedomax controllers for industrial measurements and pH indicators for laboratories.

During tests, nylon capped electrodes were boiled steadily for nine months in solutions with pH's varying from three to 14 with no effect on the material other than a slight discoloration.



## Instrument Unscrambles Metal Mix-Ups

Non-destructive testing and sorting of accidentally mixed or incorrectly processed metal parts can be done speedily by the new Model C-1 Cyclograph manufactured by the J. W. Dice Co., Engelwood, N. J. Can be used on either ferrous or non-ferrous metals and will sort raw stock, semi-finished, or finished parts by their metallurgical characteristics such as analysis, hardness, structure, case depth, etc. With a known and acceptable part used as a "standard" in adjusting the instrument, unwanted parts are quickly separated from the good ones.

The Model C-1 Cyclograph can be used as a "hand" sorter, in which case the operator watches the screen and manually throws out the off-standard parts.

Size and shape of the part presents no particular problem as test coils are wound for any size opening desired. Typical parts inspected are: bolts, nuts, screws, aircraft valves, roller bearings, AP shot, jet engine rotors, blades and other forgings, malleable castings, welding rod, automotive parts, steel and copper tubes, piston rings, ordnance items, barstock.

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NEW EQUIPMENT
BUSINESS NOTES
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## Coaxial Galvanometer Design

A new concept in the design of the moving coil galvanometer mechanism has resulted in an extremely small assembly with performance characteristics and durability exceeding existing ruggedized panel instrument movements of far greater size and weight. The small size and weight (0.8 oz) of the new mechanism make practical the use of the moving coil mechanism as a component of a great many electrical or electronic instruments or other products where previously size, weight or performance characteristics prevented their use. It is especially applicable in aircraft instruments where size and weight must be at a minimum, yet no compromise can be made with performance and durability.

The new assembly consists of a soft iron outer pole structure, a non-magnetic yoke and a magnetized core, of such diameters that the yoke fits snugly in the pole structure, and the core within the yoke. A bridge, attached by means of two screws (the only fastenings in the entire assembly) locks the assembly; a locking finger on the bridge holds the core and frame in position. Rotation of the core yoke is prevented by a slot in the bridge flange which engages one of the legs in the frame. The moving coil is contained by its pivots, and bearings located in the bridge and base of the frame.

The basic design in which all critical dimensions are *machined* from a common center (the bearing axis) gives far more precise and uniform alignment than is possible with stamped assemblies. The interlocked assembly assures maintenance of these close tolerances and affords far greater rigidity and strength than is available in conventional mechanisms, particularly when mass is considered.

For further information contact the manufacturer, Marion Electrical Instrument Co., Manchester, N. H.

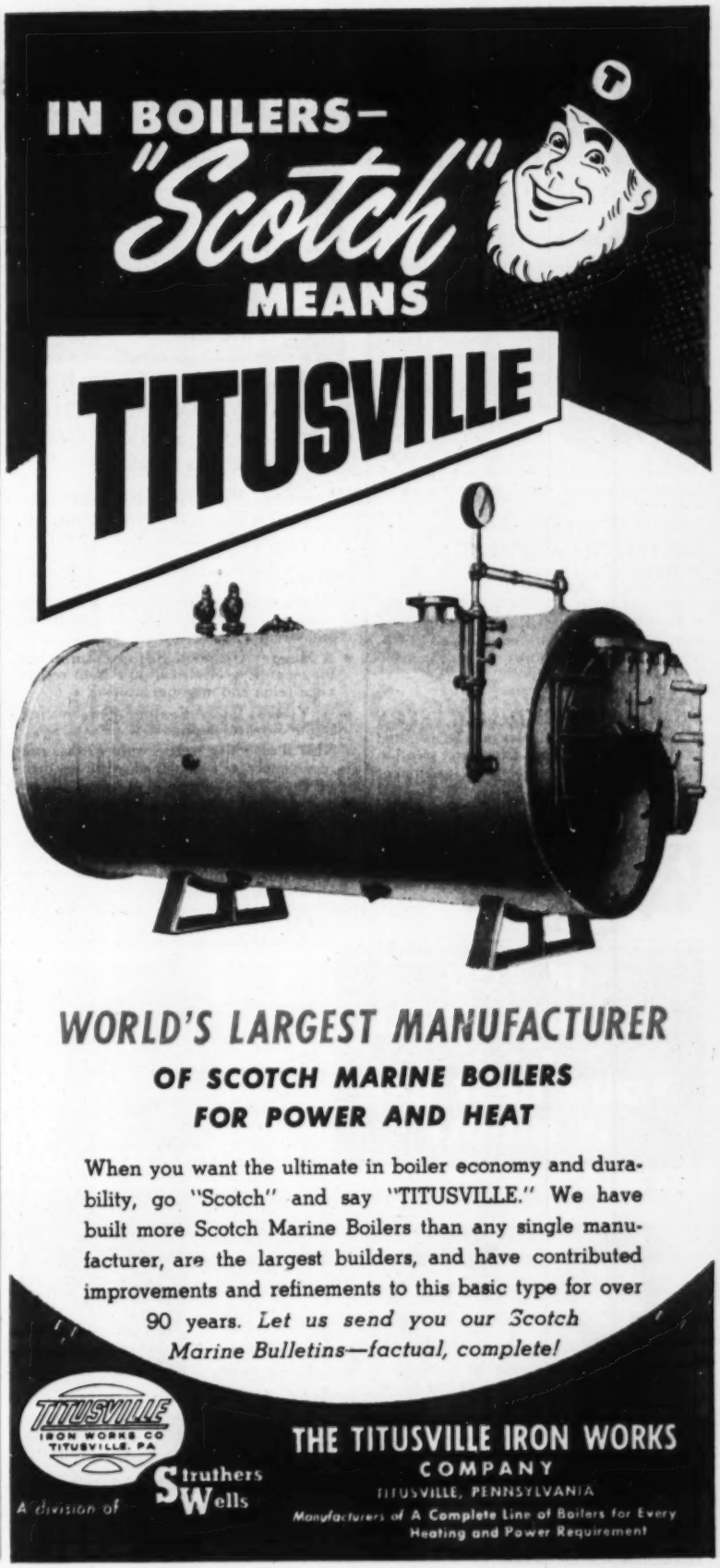
## Dust Collector

The newly developed AMERjet dust collector is a reverse jet fabric collector designed for those applications where extremely fine particles are involved or where the material must be collected in a dry state for reclaiming.

The cleaning media is automatically reconditioned by a jet of high pressure air forced through the cloth in opposite direction to the flow of the air being cleaned. Because the cleaning cycle is continuous, the AMERjet maintains a constant pressure drop and thus a steady air volume at the exhaust points.

This method of media reconditioning also permits much higher velocities through the cleaning tubes. Therefore, less filter cloth is needed for any given cfm than is required by conventional cloth envelope or bag type collectors. The size of the dust collectors needed is thus materially reduced.

Manufactured by American Air Filter Co., Inc., Louisville, Ky. Bulletin 279 is issued free upon request.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# BIDDLE *Instrument News*

## MEGGER® ELECTRICAL INSULATION TESTERS

**Hand—Rectifier—or Combination Operation—**

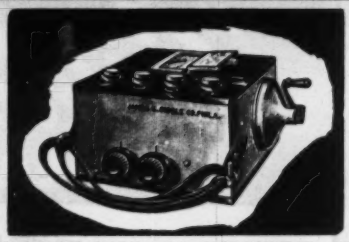
***Ratings up to 2000 Megohms and 1000 Volts D-C***

***HAND CRANK MEG TYPE*** of Megger Insulation Tester is a reliable field instrument, light, sturdy, with a constant-voltage type generator—no dependence on batteries or other current supply. By far the most popular instrument among electrical plant maintenance men. Easy to use—easy to read—and rugged in constant services.

***RECTIFIER OPERATED*** Meg Type of Megger Insulation Tester simply plugs into a convenient outlet. Portable or flush bench-mounted. A dependable production or inspection instrument. Quick, easy readings speed up otherwise costly tests.

***DUAL-OPERATED MEG TYPE*** of Megger Insulation Tester may be operated by hand or rectifier. Excellent solution for those requiring a versatile instrument for field and bench use.

**Write for BULLETINS 21-45 M 21-46 M**



## INSULATION TESTER & WHEATSTONE BRIDGE in ONE EASILY PORTABLE INSTRUMENT

**Measures Electrical Resistances From a Fraction of an Ohm up to 1000 Megohms**

***Affords the facility of:***

- **A Wheatstone Bridge** for measuring conductor resistance of coils, resistors and circuits.
- **A Megger Direct Reading Ohmmeter** for measuring electrical insulation resistance (ohm and megohm scales).
- **A Varley Loop Feature** for locating faults on wires (optional).

This Bridge-Meg weighs only 15 lbs. and is completely self-contained with its own constant-voltage generator—no need to be dependent on batteries or other suitable test current.

Why burden yourself with two instruments when you can have the facilities of two for little more than the price of one in one compact, sturdy case. For complete details and prices write for BULLETIN 21-60 M.

## IF YOU MEASURE SPEED • • • YOUR BEST BET IS BIDDLE

**Average Measuring RPM or FPM Jagabi® Speed Indicator**

**Dr. Horn Tachometer**

**Jagabi® Tachometer**

**Instantaneous Speeds or Variations in Speeds. Write for BULLETIN 35-M**

**Frahm® Resonant Reed Tachometer**

**Quick Accurate Readings with Safety**

**BULLETIN 31-M**

B-914

## JAMES G. BIDDLE CO.

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### Undercutter Bit

A new undercutter bit with stop, the CCS-2, designed especially for continuous miners is announced by Carboloy Dept. of General Electric Co., Detroit, Mich.

The new bit can be used on all cutting machines that employ $1/2 \times 1$-in. bits.

### Hydraulic Cylinders

Hydreco Div., N. Y. Air Brake Co. in Cleveland, Ohio, announces a new line of standard double-acting oil hydraulic cylinders in sizes up to eight inches effective diameter.

The cylinders have highly-polished, chrome-plated piston rods and honed tubes. Both piston and rod packing assemblies use the chevron (V-type) packing. O-rings are used for static seals only.

The new line of cylinders has a patented wiper ring that keeps dirt out of the hydraulic system and protects the packing.

### Improved Thermostat

A new thermostat for room heaters and conditioners is now being manufactured by the Westinghouse Electric Corp. Called the Room-Temp thermostat, it can be used to control air blast heaters, unit heaters, radiant heat panels, furnaces or air conditioners. Will handle currents as high as 30 amps, 125/250 v, without a circuit relay or contactor.

For further information, write the Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.

### Pressure Pickup

Where pressure transients occur too rapidly for observation with conventional indicating devices, the new electrical resistance-Type 4-312 Pressure Pickup provides immediate response to pressure changes. This latest of Consolidated Engineering's miniature pickups is available in gage, absolute, and differential models which feature high corrosion resistance and a flush-type diaphragm. It may be used for either liquid or gaseous measurements.

Further details may be had by writing Consolidated Engineering Corp., Pasadena 15, Cal. Please request Bulletin CEC-1540.

### Welding Positioners

As an addition to its line of welding positioners and turning rolls, Worthington Corp., Harrison, N. J., has announced three new heavy-duty precision positioners for automatic or manual welding. The new units are being built in 2500-, 3000-, and 6000-lb capacities.

The table on these positioners is driven by a spur gear and pinion. The reducer is bolted to the yoke. Table tilting speed is 135 deg in 40 sec and table height is adjustable in 6 in. steps. A tilt indicator is standard equipment.

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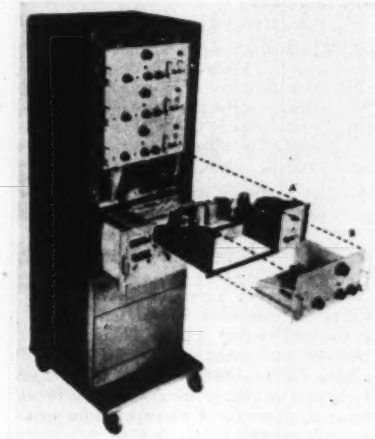

## New Oscillographic Recording System

A new four channel oscillographic recording system, announced by Sanborn Co., provides a unique combination of interchangeable "plug-in" elements which make the system applicable to the graphic registration of almost any phenomenon (individually or up to four simultaneously) within the frequency range of zero to 100 cycles per second.

The system consists of a vertical cabinet containing a four channel recorder assembly, and a built-in driver amplifier and power supply unit which are already in place, for each of the four channels. The preamplifier required for the specific application is plugged in to the appropriate channel. By changing the plug-in preamplifier, the system is adapted to recording an extremely wide variety of phenomena including stress, strain, pressure, displacement, thickness, velocity, acceleration, current, voltage, temperature, torque, light, flow, force, load, position, rpm, radiation and tension.

For catalog sheet and further information write Sanborn Co., Industrial Div., 195 Massachusetts Ave., Cambridge 39, Mass.

## Torque Converter Coupling

Adoption of the Fuller Torque Converter Coupling as the power transmission link in a number of industrial machines is reported by the Fuller Mfg. Co. of Kalamazoo, Mich.

Designed for use with engines developing from 180 to 225 lb ft of torque in the 2000–2200 rpm range, or higher, the Fuller Torque Converter Coupling delivers up to 2.1:1 torque multiplication with automatic adjustment to 1:1 coupling operation as torque demand drops.

The Model 12-A unit is equipped with SAE No. 3 flywheel housing at the output end, for attachment of conventional transmission. Model 12-S is equipped with splined output shaft. Complete information on the Fuller Torque Converter Couplings can be had by writing Fuller Mfg. Co.


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Want to see how really sharp and contrasty a print can be? Then try the new Copyflex sensitized paper—the paper that sets a new high in quality of reproduction.

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The new formula paper "perks up" weak image lines from poor originals—even captures various shades of gray in pencil sketches. Yet, notwithstanding its superior fidelity of reproduction, it provides a wider margin for operator error. Anyone can make good prints on this fine paper!

Every day you delay, you're paying for Copyflex quality but not getting it—so order today. New formula Copyflex paper comes in three speeds, in both sheet and roll form, up to a maximum width of 54 inches.

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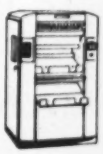

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# DRY, FRESH AIR For a Supersonic WIND TUNNEL

● New and improved, this NIAGARA METHOD that effectively dries outdoor air for a wind tunnel used for testing at supersonic speed, can be trusted to give you the best air conditions for your purpose:

- to dry your materials or products
- to prevent condensation or moisture damage
- to protect your moisture-sensitive processes
- to give you an atmosphere in which your product can be packaged or stored safely.
- to give you exactly the right atmospheric conditions for testing materials
- to put "fresh air" back into your air conditioning, increasing its capacity and effectiveness

The Niagara "fresh air" Method removes the excess moisture from outdoor air by contact with an absorbent liquid in a spray chamber. The liquid contact temperature and the absorbent concentration, both controlled thermostatically, determine the amount of moisture in the conditioned air. Heating or cooling the air is a separate function. Therefore, you can easily and inexpensively have a precisely controlled condition without the use of moisture sensitive instruments.

The Niagara Absorbent Spray Method is noted for solving the really difficult problems of air conditioning. Write for complete information.

**NIAGARA BLOWER COMPANY**

Over 35 Years' Service in Industrial Air Engineering

**Dept. ME, 405 Lexington Ave. New York 17, N. Y.**

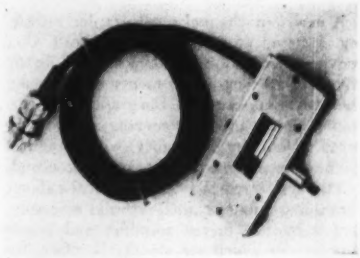
*Field Engineers in Principal Cities of U. S. and Canada*

## Oil Separators

The Eclipse Fuel Engineering Co., Rockford, Ill., announces a new simplex and a new duplex type oil separator for pressures up to 250 psi to their line of heating equipment. These units are to be used mainly in the circuits of new Eclipse "CF" closed flame gas-oil burners. The filters can be used for coarse straining or fine filtration.

Construction of the separators makes cleaning or interchanging of strainers and filters an easy matter. A yoke-type holder at the top of the filter housing simplifies removal of the various elements.

Both types of separators have special adjustable positioning collars for accurate location and seating of a hand lapped rotor. There are no springs in the units to cause wedging the rotor to its seat. A wide range of strainers and filters are available for these units. Approved by Underwriter's for pressures up to 125 psi on fuel oil.



## Eccentricator

A compact Eccentricator, which eliminates the need for observing maximum and minimum indicator readings and computing the difference when measuring workpieces for eccentricity, announced by Federal Products Corp., 1144 Eddy St., Providence, R. I.

The Eccentricator can also be used, in special applications, for checking run-out, squareness, straightness, wobble, etc., while ignoring normal variations in size of different workpieces. This instrument, always used with suitable indicating power units either electric or electronic, is adjustable over a wide tolerance range of .0001 in. to .035 in. T.I.R. Because of its narrow $1/2$-in. thickness it can be mounted $9/16$ in. on centerline. Its tolerances are set using any Federal dial indicator placed at the upper end of the spindle.

The Eccentricator can be used for sorting to sizes with over and undersize tolerance lights, or it can be employed on high-speed, completely automatic electronic gages to measure eccentricity, squareness, run-out, straightness and wobble.

Any number of Eccentricators can be mounted side-by-side either horizontally or vertically for multiple dimension gaging at close quarters. The instrument has satin chrome finish and weighs only 14 oz. Dimensions $1/2$ in. thick x $3\ 7/8$ in. wide x $1\ 3/4$ in. high.

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BUSINESS NOTES
LATEST CATALOGS

## Electro-Magnetic Clutch for Variable Speed Transmission

No sudden starts or stops, controlled acceleration from zero to running speed, are the result of combining an electro-magnetic clutch with the Reeves variable speed transmission.

This new combination of electric motion control and the Reeves transmission, manufactured by Reeves Pulley Co., Columbus, Indiana, makes possible: Controlled acceleration; Controlled deceleration; Selection of operating speeds while machine is stopped; Jogging and inching.

The rate of torque build-up is easily adjusted and controlled, automatically or manually, through the separate control panel that is furnished with this drive. Rate of acceleration may be adjusted for synchronizing motions, registering, inspection, etc. Because of the high, electro-magnetic torque, no creep or slippage is possible when the clutch is "lock-in."

The electric clutch is now available on sizes No. 0, 1, 2, and 3, Reeves Horizontal Transmission.

For complete details, write Reeves Pulley Co., Columbus, Ind., and request bulletin G-537.

## Indicating Thread Gages

The George Scherr Co., 200 Lafayette St., New York 12, N. Y. announces a new line of Indicating Thread Gages. One is a roller thread pitch diameter comparator gage and the other a dial thread plug gage for checking internal threads. Both instruments are designed for quick inspection by unskilled operators. All errors due to unequal pressure and "feel" are eliminated. The roller thread pitch diameter comparator gage has an indicator gage reading in .0001 in. and is set by means of a master thread gage.

The dial thread plug gage measures internal threads quickly by means of three interchangeable measuring jaws, of which the middle one is retractable between the other two. The instrument comes in three sizes for ranges of thread diam. $^{3}/_{16}$ in. to 1 in., $1^{1}/_{16}$ in. to $2^{1}/_{16}$ in. and $2^{1}/_{8}$ in. to $4^{3}/_{4}$ in.

A circular with illustrations and description on both instruments and a price list including information on master thread gages and ring gages can be obtained from George Scherr Co.


HEAT UP STEAM UNITS
8 TIMES FASTER With
NEW HEAT-KWIK
Super-Silvertop
Steam Traps

WRITE FOR OUR NEW CATALOG Today!

● Here's the most profitable steam trap news to reach your ears in many years! The new Heat-Kwiks vent air out of steam consuming units *eight times* faster than ordinary inverted bucket traps . . . three times faster than air eliminator or blast type traps. This faster removal of air means faster heating up . . . more production . . . lower steam consumption . . . and reduction in trap capacity factor. Use Heat-Kwik Super-Silvertops on every steam-using unit. You'll get heat much faster . . . and reduce steam costs. The savings will quickly pay for your Heat-Kwik investment.

SUPER-SILVERTOPS
Quality Steam Traps Since 1886

SUPER-SILVERTOP STEAM TRAP

THE V. D. ANDERSON COMPANY
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Gentlemen: Without obligation please send me the following information:

☐ Bulletin 1153 (Heat-Kwik Steam Traps)
☐ Solving Steam Trap Problems (36-page catalog)
☐ Bulletins on Hi-eF Purifiers

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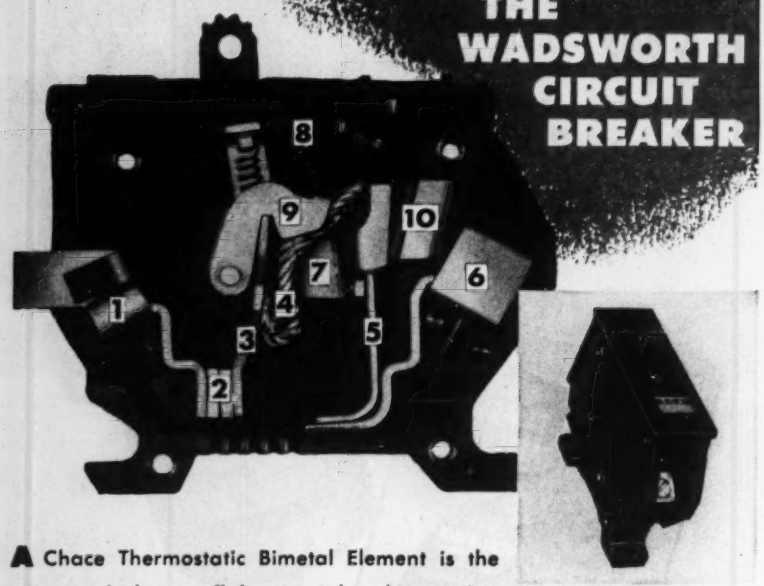
ANDERSON

## how CHACE [illegible] TRIGGERS THE WADSWORTH CIRCUIT BREAKER




A Chace Thermostatic Bimetal Element is the trigger which sets off the circuit breaking action in the Wadsworth Thermal-Magnetic Circuit Breaker when an electrical overload occurs. The Wadsworth unit operates automatically or manually and features the "E-Z-Red"® indicator which shows clearly when the circuit has been opened automatically.

A Product of
Wadsworth Electric Mfg. Co.
Covington, Kentucky

The line connection to the unit is indicated by (1) in the cutaway view. The current passes through contacts (2), switch arm (3), pigtail (4), Chace bimetal element (5) and through solderless connector (6) to load terminal.

An increase of temperature because of short circuit or overload causes Chace bimetal element (5) to flex to right, releasing latching ear (7). This allows spring-loaded rocker (9) of which (7) is a part, to move counter clockwise. Switch arm (3) follows due to tension of the spring, and over center action opens contacts (2). The "E-Z-Red"® indicator (8) projects at the same time to indicate the breaker has tripped automatically. Magnetic element (10) accelerates flexing of bimetal at beginning of operating cycle.

**Leading builders of temperature responsive devices throughout the world specify Chace Thermostatic Bimetal in their products. If your product controls or indicates temperature changes, you will be interested in our new 36-page booklet giving 22 uses of thermostatic bimetal and data on element design and selection. Write for it today.**

W. M. CHACE CO.
Thermostatic Bimetal
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KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

### Delta Band Saw

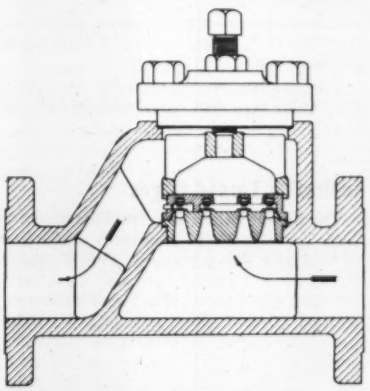
Delta Power Tool Div. of Rockwell Mfg. Co. has introduced an improved version of its standard 20-in. band saw featuring rubber tires fused to pre-faced demountable steel rims.

Use of the new tires—known as "Carter Jiffy Tires"—will reduce machine downtime and overcome a major service problem in the woodworking industry, Delta officials reported.

For further information, write Delta Power Tool Div., Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa.

### Motor Base Has Vertical Adjustment

Six-inch vertical adjustment is provided by the LMV motor base. Besides saving floor and machine space, it provides the great amount of adjustment required where driving wheels that operate with endless belts or chains, are changed. The vertical motion is also great enough for use with the spring loaded type of variable speed motor pulley. The base is all steel fabricated construction. Base accommodates electric motor frame 284—7½ hp at 1800 rpms, 5 hp at 1200 rpm, or 3 hp at 900 rpm. Center adjusting screws can be shortened where full 6 in. movement is not required. For further data write Quintin James Kearney, 220 Congress Ave., Lansdowne, Pa.



### High Pressure Airchek Valves

Those needing Airchek valves for higher than usual pressures can get them to suit conditions of service as high as 500 psig. Installed on the discharge line of air and gas compressors this valve checks down time, noise, vibration and tank ring; also, replaces stop and safety valves.

Airchek valves are automatic and remove the forgetfulness of personnel to open a valve before starting up.

Quiet and long-lived, they do not bang themselves to pieces. Described in Bulletin 509-C available from Pennsylvania Pump & Compressor Co., Easton, Pa.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
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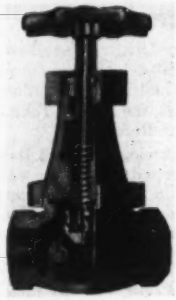


## Eliminates Causes of Valve Failure

Re-christened "Gyroseal," the Richmond Foundry and Mfg. Co., Richmond, Va., is now producing its new and improved version of the Ostlind Valve. Gyroseal valves eliminate the causes of valve failure by causing the disc to rotate rapidly at the moment of closure. Foreign particles are thrown off by centrifugal force and the turbulence created keeps the particles in suspension while the disc is gently polished against the seat.

## New Heavy-Duty Towing Tractor

A new field-tested heavy-duty towing tractor with a maximum draw bar pull of 7500 lb, designed for general purpose industrial applications, as well as for specific uses by airlines and aircraft companies, is now available from the Clark Equipment Co., Battle Creek, Mich., a leading manufacturer of materials handling, and bulk handling and construction equipment.

The Clarktor-75, priced at $4,800 f.o.b. Battle Creek, completes Clark's towing tractor line, which now includes units in capacities from 500–12,000 lb draw bar pull.

## Cellular Rubber Floats

First developed for carburetors using aircraft fuels, floats of rigid cellular rubber known as "Spongex Cell-Tite" made by The Sponge Rubber Products Co. of Shelton, Conn., are gaining acceptance for many other types of float applications. Chief reason for the material's suitability for all kinds of float applications is its permanent buoyancy which derives from its rigid structure of myriad non-interconnecting cells rather than a hollow form. Thus the maker's claim that the buoyancy of "Spongex Cell-Tite" cannot be destroyed by absorption, puncture, or collapse. An uninterrupted surface assures that none of the float's volume need be sacrificed to external dimensions such as may be established by the raised seams of conventional hollow metal floats. The firm also states that the material's buoyancy may be altered by varying the density—this to circumvent costly re-tooling of float and chamber components when buoyancy changes are called for.

Density of "Spongex Cell-Tite" ranges from 5 to 20 lb per cu ft with compressive strength from 30 to 300 psi, depending upon density. The material compounded for carburetor floats gains but a few milligrams under conditions of 30 psi for 72 hours when immersed in SR-6 test fluid (5 per cent benzene, 15 per cent xylene, 20 per cent toluene, 60 per cent diisobutylene).

Grating by BLAW-KNOX

# what can steel grating do for you?

You naturally think of steel grating for floors, platforms, walkways, catwalks and stair treads.

But have you ever thought of how steel grating can make your danger spots safe . . . by covering an unprotected open pit or light well, by guarding a fan, by providing some sturdy shelving, or by serving some purpose you'd never thought of before. Look around your plant, both inside and outside, to see where you can use versatile steel grating . . . to make your plant an even better, safer place to work.

If you come across some tough problem on a grating application, we'll be glad to offer our suggestions.

**Only Blaw-Knox Electroforged® Steel Grating and Stair Treads —have these five exclusive features:**

1. rigid one-piece construction—easy to install
2. all surfaces accessible—easy to paint
3. no sharp corners to clog—self-cleaning
4. maximum open area—for light and ventilation
5. non-slip twisted crossbar—safe footing

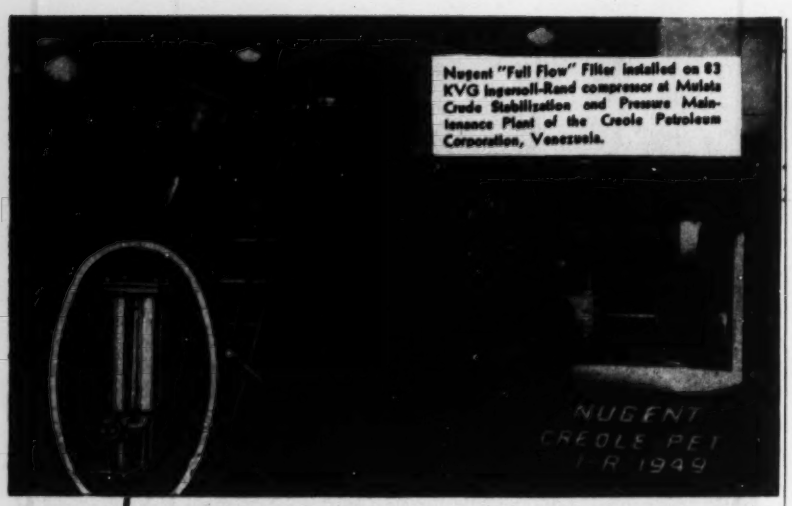
*A short note will bring you a copy of new Bulletin No. 2365-R —a dimensional sketch will bring you a quotation.*

BLAW-KNOX

**BLAW-KNOX COMPANY**
2105 Farmers Bank Building • Pittsburgh 22, Pa.

**BLAW-KNOX EQUIPMENT DIVISION GRATING DEPARTMENT**

GRATING APPLICATIONS: floors • platforms • walkways • catwalks • stair treads • fan guards • shelving • and many other uses, both outdoors and indoors, for versatile steel grating


Nugent "Full Flow" Filter installed on 83 KVG Ingersoll-Rand compressor at Mulata Crude Stabilization and Pressure Maintenance Plant of the Creole Petroleum Corporation, Venezuela.
NUGENT
CREOLE PET
I-R 1949

## DON'T OVERLOOK THIS CRUCIAL POINT IN COMPRESSOR OPERATION

NUGENT FILTERING MEANS TRIPLE SAVINGS

IT'S the lube oil filtering system, and it can play a big part in your profit and loss statement.

If you put a Nugent "Full Flow" filter in that spot you can be sure of stopping 99.8% of the harmful impurities that get into lubricating oil before they reach the vital working parts of the compressor. This is the kind of filtering that pays for itself many times over in oil savings, increased equipment life and reduced maintenance.

In Nugent "Full Flow Filtering" all the oil being circulated through your equipment is filtered every cycle. No part of the contaminated oil bypasses the filter. Dirt that is removed from the oil collects inside the special Nugent filter bags. When these bags fill up they can easily be cleaned and reused or new replacement bags are inexpensive. In addition, Nugent filter bags have 20 times more filtering capacity than others of comparable size.

Whatever type of machinery you use — compressors, gas engines or diesels — Nugent Filters can answer your filtering problems. There is a size and type for every need. Write for complete details.

Longer Machine Life

Less Maintenance

Less Oil Replacement

Wm. W. Nugent & Co., Inc.
1409 N. Hermitage Ave. CHICAGO 22, ILLINOIS

### Multipoint Chart Recording

Fielden Instrument Div., Robertshaw-Fulton Controls Co., Philadelphia, announces a new approach in multipoint recording through two new models, the Fielden Tektolog and the Null Balance Recorder.

The new Fielden Tektolog and Null Balance Recorders are expected to open the way for low-cost recording in many applications formerly considered economically unfeasible. The Tektolog is accurate to plus or minus 1 per cent of full scale and features a sensitivity of 0.1 per cent with a reproducibility of plus or minus 0.5 per cent. Inputs range upwards from 50 micro-amps DC and 30 milli-volts DC. It can be used to record almost any electrical quantity or be used in 2-wire DC telemetering system.

Both new Fielden 24-point recorders feature a simple trouble-free mechanism requiring a minimum of maintenance. Initial cost is approximately $45 per point and operating costs are well below those of conventional strip recorders. Charts are easy to file and easy to refer to since all 24 traces are visible at one time.

For additional information write R. M. Stotsenburg, Sales Manager, Fielden Instrument Div., Robertshaw-Fulton Controls Co., 2920 N. Fourth St., Philadelphia 33, Pa.

### New Oil Recovery Unit

Electrically controlled and operated, the new "Kleer-Stream" automatic oil recovery units announced by Pioneer Pump Div. of Detroit Harvester Co., 2750 Guardian Bldg., Detroit 26, Mich., are designed to recover reusable oil and assist in reducing stream and lake pollution.

Pioneer's "Kleer-Stream" oil recovery unit is for use with parts washers, coolant sumps and reservoirs handling liquids which contain oil. It saves washing solutions, oil and applied compounds.

The function of the "Kleer-Stream" unit is wholly automatic with float and solenoid valve control. When used in conjunction with parts-washing machines or reservoirs and supply lines containing immiscible liquids which may be discharged into the unit by gravity flow, no auxiliary pump is required. In such applications the liquid containing oil is supplied to the recovery unit by pipe or hose connections.

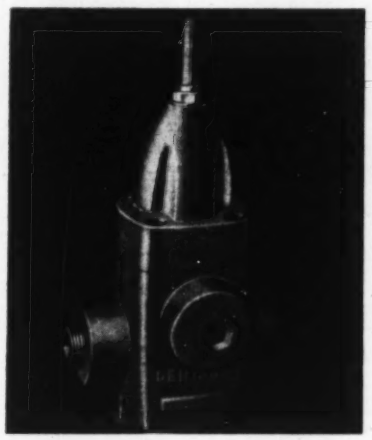
The new unit will be unveiled to industry for the first time at the American Society of Tool Engineers Industrial Exposition in Philadelphia next April.


Use a CLASSIFIED ADVERTISEMENT *for Quick Results*

## Torsion Spring Tester

A universal tester to check loads and deflections of torsion, double torsion, spiral, clock and power springs is now commercially available for the first time. It is especially useful in inspection departments of spring and product manufacturers, government arsenals and laboratories. It can be used for high quantity production testing of torque and angular travel at speeds of 300 to 600 tests per hr.

The tester meets requirements of National Bureau of Standards for precision scales and is guaranteed accurate within $^1/_4$ of 1 per cent. Torsion springs having wire diam. from .005 in. to .125 in., OD from $^1/_{16}$ in. to 6 in., lengths from $^1/_{16}$ in. to 6 in. can be tested for torque from $^1/_4$ in. oz to 48 in. lbs. The Carlson Co., 277 Broadway, New York 7, N. Y.



## Direct-Operating Sequence Valve

The newly announced line of direct-operating controls by Denison Engineering Co., 1189 Dublin Road, Cleveland, Ohio, includes a complete line of direct-operating sequence valves suitable for operation in circuits from 25 to 2000 psi.

The line provides precision control for inter-locked hydraulic operations, insuring close synchronization of primary and secondary operations. The pressure setting of the valve is easily adjusted. When system pressure reaches the pressure setting of the valve, the valve diverts oil to the secondary circuit.

Valves are easily adaptable to a variety of remote control operations by rearrangement of pipe plugs.

The Denison Direct-Operating Sequence Valves are supplied in threaded body style in $^1/_2$", $^3/_4$", $1^1/_4$" sizes. Subplate type is available in $^3/_4$" and $1^1/_4$", and the Flange Body is supplied in the $1^1/_2$" size. Pressure ranges are 25-125 psi, 75-250 psi, 125-500 psi, 250-1000 psi and 1000-2000 psi. Half-inch sizes have a 15 GPM capacity, $^3/_4$" handles 20 GPM, $1^1/_4$", 65 GPM and $1^1/_2$", 80 GPM.

to maintain correct pumping rates
for accurate metering and proportioning
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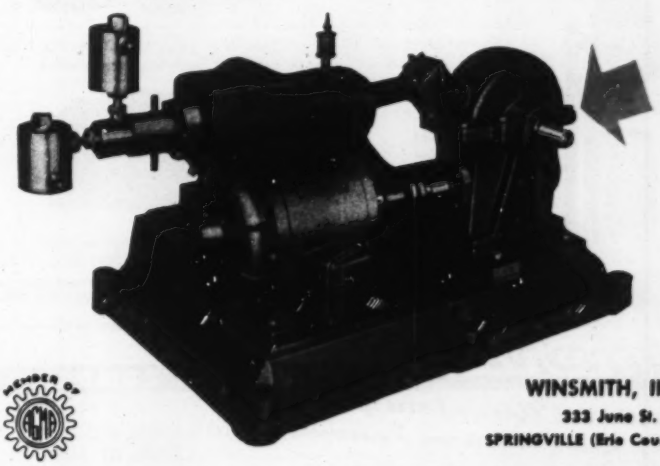
Metering and proportioning the flow of abrasive slurries, corrosive chemicals, viscous or semi-viscous fluids and numerous other chemicals, %Proportioneer% Adjust-o-Feeders are called upon to deliver precise, pre-set dosages. And they do! They're equipped for accurate, continuous and dependable service.

A fully enclosed Winsmith Speed Reducer with specially designed gears for reciprocating pump service, provides the required reduction ratio. *Precise speeds are assured!*

Among the reasons for using Winsmith Reducers, %Proportioneers, Inc.% emphasizes " . . . the very complete cooperation received in working out individual problems".

And who is in a better position to be helpful than a Winsmith representative? With rugged, compact and fully standardized units available in differential, worm and helical gear designs, the Winsmith line is the most complete within its range of 1/100 to 85 hp in ratios of 1.1:1 to 50,000 to 1. Request catalog 148 for details.



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Much depends upon the size and construction of your chimney. Improper draft can waste fuel, reduce power and cause endless trouble. Old chimneys with eroded linings and cracks or spalled areas are equally wasteful.

With production costs at an all-time high and plant efficiency an absolute necessity, it might be well to check your chimney. Phone, wire, or write and a Consolidated Engineer will inspect your chimney at no inconvenience to you and make whatever recommendations are necessary.

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250 ft. x 12 ft. Reinforced Concrete Chimney designed and built for Amalgamated Sugar Co., Nyssa, Ore.

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# KEEP INFORMED

NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

## New Motor

A completely new motor with numerous revolutionary features and conforming in every particular with NEMA specifications is announced by U. S. Electrical Motors Inc. By increasing precision of manufacturing processes, holding tolerances to closer limits and improving the electrical characteristics, this new motor, designated as Uniclosed, Type H, is more compact than previous models. One outstanding feature is its complete drip-proof design which also offers splash proof protection without increased cost. The frame is solid, one-piece cast iron and the stator is pre-wound. Frame sizes 182–184 are now available. By utilizing the interior space to better advantage, the motor is built more compactly so that the same horsepower can be embodied in less space. The end brackets are of entirely new design with air intakes so arranged as to prevent intrusion of water, yet allow liberal air flow into the motor for 2-way ventilation. Baffles of an entirely new design within the air vestibules of the end brackets prevent splashings from entering and coming in contact with the windings.

Literature describing Type H Uniclosed motor may be obtained from U.S. Electrical Motors Inc., Box 2058, Los Angeles 54, Calif.

## FHP Motors for Cooling Fans.

A new line of two-speed fhp motors, available for summer-cooling applications, has been announced by the General Electric Company's General Purpose Component Motor Dept., Schenectady 5, N. Y.

The line of motors is made up of split-phase and capacitor-start types with speeds of 1725/1140 rpm. The split-phase models are rated at $^1/_6$, $^1/_4$, and $^1/_3$ hp, 115 v, 60 cycles. The capacitor-start models are rated at $^1/_2$ and $^3/_4$ hp, 115 or 230 v, 60 cycles. Single-speed motors for fan applications are also available in these ratings.

## New Type Revolving Joint

Introduction of an improved, light running, Revolving Joint with $^1/_4$-in. ID for making air or hydraulic piping connections to clutches, power transmission drive units, chucks, spindles, grinding wheels, and other rotating machine parts is announced by Barco Mfg. Co., Barrington, Ill. The new joint, designated as "Type NV," features (1) a compact new one-piece bronze casing, (2) special spring loaded V-ring seals, (3) hardened and ground steel shaft, (4) permanently lubricated, sealed ball bearing. All parts are readily removable and replaceable.

Address inquiries for further information to Barco Mfg. Co., Dept. J—500 Hough St., Barrington, Ill.

## New Electronic Digital Computer

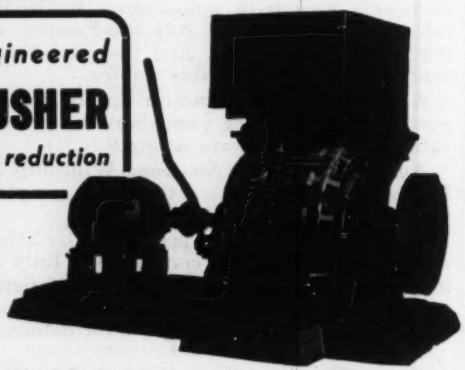
A true general purpose mathematical machine, the new Consolidated 203 Digital Computer is not limited to any specific field of activity but is adaptable to almost any problem reducible to numerical terms. Although midway on the price spectrum of digital computers already developed, the 203's unusual speed, capacity, and versatility make it capable of handling not only the problems of research and engineering but also those of industry, finance, and commerce. A thoroughly proven central component of computation systems assembled to the specific needs of the customer, the computer has already solved problems ranging from aircraft flutter studies and boiler design to interest-rate calculations and geophysical data reduction. Five complete computer systems are currently scheduled for delivery during 1954.

All additions, subtractions, logical shifts, and transfers are performed at an average rate of 500 per sec, while multiplications are accomplished at 120 per sec and divisions at 85 per sec. These typical operational rates include obtaining the 10-decimal-digit words (numbers or commands) from the quick-access portion of the memory.

Further information may be obtained by contacting Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif.

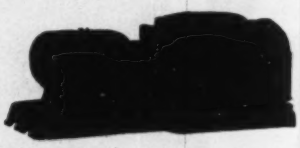
*There's a job-engineered*
**AMERICAN CRUSHER**
*for uniform . . . low-cost reduction*

. . of COAL, CLAYS, CHEMICALS, STONE, METAL TURNINGS, WOOD, DRY ICE, FOOD—hundreds of products of every description.



*Metal Turnings Crusher*—reduces long, curly turnings of steel, alloys, brass, aluminum, etc., to uniform chips for highest cutting oil recovery . . . increased scrap value.

*Laboratory Mill*—for testing pilot plant operation and waste reduction.



*"AC" Ring Mill*—with exclusive shredder rings—for uniform, high tonnage reduction. 500 TPH. "24 Series" ring or hammer crushers offer capacities to 50 TPH . . . . . "30 Series" Hammermills to 100 TPH.

Write for complete information on the famous American line of crushers.

American PULVERIZER COMPANY
*Originators and Manufacturers of Ring Crushers and Pulverizers*
1541 MACKLIND AVE.
ST. LOUIS 10, MO.

## Reducing Valve

A new pilot-operated steam reducing valve has been announced by Klipfel Valves, Inc. The new valve, No. 933, meets the needs of most steam reducing valve installations; pressure adjustments are easily made.

The valve is manufactured in sizes from ¾" to 6". Sizes below 2" have bronze bodies; larger sizes are semi-steel. Stainless steel discs and seats are used in sizes 4" and smaller; 5 and 6" sizes are supplied with bronze inner valves and seats, but can be furnished with stainless trim on special order.

Complete literature will be mailed on request to the manufacturer, Klipfel Valves, Inc., Hamilton, Ohio.

## New High-G Power Relay

New power relays that operate reliably even under the high temperature, high shock, and high frequency vibration found in military aircraft, rockets, and guided missiles, have been developed by Hetherington, Inc., Sharon Hill, Pa.

Known as Hetherington "Hi-G Relays," the new units are available in four basic series—the High-G types that withstand 20G vibration at over 500 cycles per sec; Standard types for 10G vibration at 55 cycles; special High-Temperature types; and Industrial types for less severe applications.

Other Hetherington "Hi-G Relays" are available at lower cost for industrial applications with more moderate shock and vibration requirements. Details on all types are available on letterhead request to the manufacturer.

## Mechanical Flow Meter

The Penn meter, introduced by Cochrane Corporation more than 35 years ago, has been given a "face-lifting" for adaptation to present-day panel instrumentation. The basic operating principle of a U-tube balance has not been changed dynamically or dimensionally, so that it is still considered the most powerful mechanical meter available. It records flow on evenly graduated charts and may be equipped with pneumatic transmitter which provides air output directly proportional to flow. Utilization of torsion tubes have eliminated the necessity of springs, bellow, stuffing boxes or pressure-tight bearings. The new design incorporates a rugged simplicity and is virtually trouble-free, requiring little or no maintenance over long periods of time. Calibration can be accurately and quickly checked without disturbing the pipe connections, and the differential range may be altered at any time by merely changing the cam weight.

For additional information, write to Penn Industrial Instrument Corp. 4110 Haverford Ave., Philadelphia 4, Pa.

## Machining Titanium Alloys

In machining titanium alloys, Carboloy Dept. of General Electric Co., Detroit, reports tool failure on all tools is generally due to excessive cratering on top of the tool. This problem, however, can be reduced with a proper grade of cemented carbide, although the low modulus of elasticity (stiffness) of titanium may cause chatter or vibration of the workpiece—if it is not rigidly supported. One way to get around this latter condition is to hone a 45-deg. land on the cutting edge 0.005 to 0.010-in. wide. If this does not provide the desired results, reducing the feed may be the answer.

One of the most important factors in machining titanium is to determine whether the material is in the commercially pure or alloyed class. Alloys such as Ti-140A and RC-130B contain about 8 per cent alloying elements and balance titanium. Commercially pure titanium such as Ti-75A contains about 1 per cent impurities, and the balance titanium.

When machining commercially pure titanium such as Ti-75A use the same tools, grades of carbides, feeds and coolants as for titanium alloys but about double the speeds.

For further information write Carboloy, Department of General Electric Co., Detroit 22, Mich.

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*For QUICK Results*

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**SEE** how others cut production costs

**"MULTIPRESS—Blanking & Forming"**

A 10-minute, 16mm sound film . . . close-ups of several production jobs *including the fastest hydraulic press operation you've ever seen!* Ideal for ASME meetings, student groups, production clinics!

***Other 16mm Sound Films***

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30 minutes of Multipress action on broaching, trimming, forming, marking, crimping, assembling, staking and pressing jobs.

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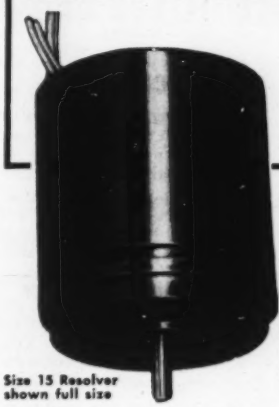
A 20-minute film showing how Multipress ends lost time and motion with a space-saving 13-step assembly line for 34-piece auto door latches.

Write Denison, or the Denison representative in your area, about the films you'd like to use—and when. *No obligation whatever.*

**The DENISON Engineering Co.**
1189-A Dublin Rd., Columbus 16, Ohio

**NEW! Ford Instrument**

**Size 15 TELESYN® RESOLVER**



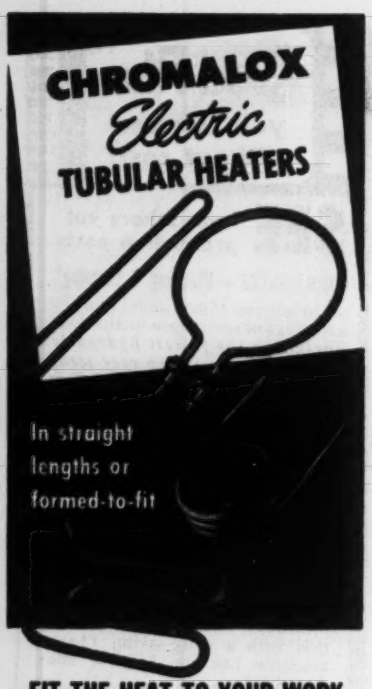
Size 15 Resolver shown full size

- Extremely accurate computing unit
- Resolves input voltages into sine and cosine components
- Miniature size
- Lightweight
- Precision built to meet rigid military requirements
- Rated 1-24 volts, 400 cycle input

The Ford Instrument Size 15 Telesyn Resolver is available in three models with transformation ratios of 1:1, 4:1, and 8:1 . . . making it adaptable to numerous applications: analog computers, angle data transmission systems and similar equipment.

**WRITE FOR FULL DETAILS—this data sheet gives you the complete facts. Address Dept. ME**

**FORD INSTRUMENT COMPANY**
*DIVISION OF THE SPERRY CORPORATION* 13
31-10 Thomson Avenue, Long Island City 1, N.Y.




**FIT THE HEAT TO YOUR WORK**

Chromalox Electric Tubular Heaters are available in straight lengths or they may be curved and formed to fit your exact specifications. They provide accurately controlled, economical and dependable convection, conduction or radiant heat. Use them for dies, molds, platens; as immersion heaters in liquids, soft metal and molten salts; or in ovens, air ducts and other air heating applications. Consult Chromalox now for all your production heating needs.

For Full Details
Write for Catalog 50. It lists Chromalox Tubular Heater sizes, types and ratings; sheath materials, fittings and special shapes.
CHROMALOX

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EDWIN L. WIEGAND CO., Industrial Division
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**CHROMALOX**

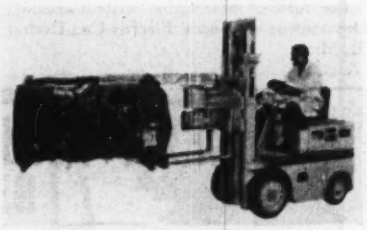
*THE BEST IN ELECTRIC HEAT*

## Hydraulic Powered Bending Machine

A new semi-automatic hydraulic powered machine that makes bends varying from $^3/_4$-in. to 2-ft radius in finned or plain ferrous and non-ferrous metal tubing up to 40 ft long has been added to the line of tube bending machines made by Walter P. Hill, Inc., 22183 Telegraph Rd., Detroit 19, Mich.

The new machine bends tubing up to $1^1/_2$-in. diam around a cone-shaped steel die that is adjustable both vertically and horizontally to provide bending radii in infinitely variable increments within the large and small diameters of the cone. Larger bend radii up to 2 ft are attained by nesting hardwood cones of larger sizes over the conical steel die. Four hardwood cones provide the radius range up to 2 ft.

The machine has a bending table powered by a high torque, positive displacement, single vane, one revolution hydraulic motor. Smooth action of this hydraulic drive enables the new machine to bend finned or plain copper tubing on an 11-in. diam without annealing.



## Swinging Clamp Device

A swinging clamp attachment which can reach out to either side of a narrow aisle to grasp or tier loads behind material already stacked, is now available for use with all gas- and electric-powered Carloader models of fork lift trucks manufactured by Clark Equipment Co., Industrial Truck Div., Battle Creek, Mich.

## Weld Strength Calculator

A weld strength calculator has been made available by Lukens Steel Co., Coatesville, Pa., for the designers, engineers, and others interested in steel plate fabrication.

A companion tool to Lukens' plate size selector, the weld strength calculator is a plastic slide rule that indicates both the size of weld required for a given applied load and the weight of a given length of weld in pounds. The calculator gives values for stresses ranging from 2000 to 20,000 psi, and applied loads of from 9000 to 450,000 lb.

On the reverse side of the pocket-size calculator, basic design data for welded connections is graphically shown, and formulas for calculating nominal properties of welded connections are listed. The weld strength calculator is available from Lukens' marketing service department.

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Natural laws don't change . . . but engineering imagination and ingenuity find unique applications for them at Jack & Heintz. As a result, our *Rotomotive* devices—electrical, hydraulic and mechanical—solve many problems which have no precedent.

***EXPERIENCED ENGINEERS***
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**17623 Broadway, Cleveland 1, Ohio**

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

## Metals and Machinery Cleaner

Development of a complete line of seven emulsion cleaners was announced by Turco Products, Inc., 6135 S. Central Ave., Los Angeles, Calif. These offer a very simple spray-on method of removing grease and oil from metals and machinery. Added in small amounts to petroleum solvents, Turco emulsion cleaners act with these solvents like soap acts with water. They increase the penetrating power of the solvents, and speed the cleaning action and improve the rinsing properties.

Complete literature on this new emulsion cleaner line is available upon request.

## New Coupling

This new coupling is designed especially to ease and simplify the process of connecting tubing or pipe in any size range and for any purpose. The Meca coupling is the essence of simplicity requiring absolutely no threading, flares, ferrules, or tools of any kind to make the connection. In a matter of seconds the most inexperienced can connect the tubing or pipe into a sealed connection able to withstand extremely high pressures. Press the spring clip, insert the tube, release the spring and that's all there is to do. Absolutely no wrenches required, saving expensive labor time.

The Meca coupling will be available in all sizes to fit the needs of all industries and applications, also in different types of materials and designed with special O-rings for any type of liquid, gases or temperatures. Built to withstand severe tests and provide leakproof performance. The O-rings can be by specification applied to high or low pressure uses. Available also as tees, elbows and connectors with a threaded end and hexagon outside for connecting into present equipment.

The Master Enterprise Corp. of America, Executive Offices, Boulder Building, Tulsa, Okla.

# Here's what micarta® LAMINATED PLASTICS is doing for aviation progress!

Aircraft manufacturers needed a pulley material that was light yet durable enough to withstand torturing cable loads at terrific speeds. MICARTA® proved to be the answer. Now over 50 million pulleys have seen service.

## What can Micarta do for you?

Your particular problem may call for a material which will fight off rust, acids or corrosive atmospheres. Perhaps you need a light-tough-resilient combination of qualities. Whatever your problem is, it's highly probable that you'll be able to choose your answer from among the dozens and dozens of pay-off qualities of this amazing material.

For the complete story on this basic material just fill out the coupon below. J-06538

YOU CAN BE SURE...IF IT'S Westinghouse

Westinghouse Electric Corporation • Micarta Division, Trafford, Pa. • Attention: L. A. Padley

micarta is basic!

Sir: (Please check one)
☐ Please have your representative call
☐ Please send me the complete facts on MICARTA

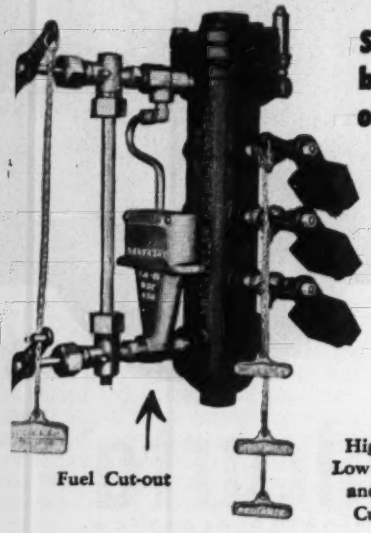
Name_____ Company_____

Address_____

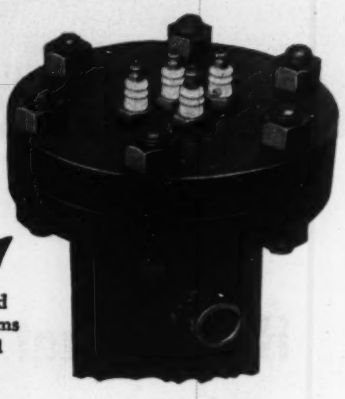
City_____ Zone_____ State_____

# New Reliance Levalarms

**. . . simple, safe, sure controls for audible and visible water level alarms and fuel cut-out**



**Simple, rugged—unaffected by pressure, temperature or water conditions**



Fuel Cut-out

High and Low Alarms and Fuel Cut-out

Using isolated circuits of low amperage, the new electrode-type Reliance Levalarms avoid troubles usually encountered with water level alarm and fuel cut-out devices. Without bellows or stuffing boxes; without vacuum tubes or magnets, these controls take their commands direct from the boiler water itself as it rises or falls in the water column.

One style adds the facility of a positive fuel cut-out control to float-operated whistle alarm columns. Other models provide high and low alarm *and* fuel cut-out facilities, and pump cut-in and cut-out if desired. In some instances the new Levalarms can be added to water columns already in service. Their installation is easy for any engineer. Write today for Bulletin D2 covering Electrode-type Levalarms.

**THE RELIANCE GAUGE COLUMN COMPANY**
**5902 Carnegie Avenue • Cleveland 3, Ohio**

*The name that introduced safety water columns . . . . in 1884*

**Reliance®**

**BOILER SAFETY DEVICES**


KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

## Industrial Hydraulic Accumulator

The Parker Appliance Co., Cleveland 15, Ohio, announces development and manufacture of a new piston type industrial hydraulic accumulator.

The new accumulator furnishes hydraulic power at extremely high oil flow for relatively short cycles of operation intermittently. The accumulator can function as: (1) auxiliary source of energy in intermittent-duty systems; (2) emergency source of fluid power for operation of a secondary hydraulic system; (3) surge chamber or shock absorber; (4) leakage compensator in a closed or pressure regulated circuit; (5) thermal expansion compensator; (6) dispenser of fluids under pressure.

Catalog File 1536A, offering descriptive information, is available from Industrial Hydraulics Div., The Parker Appliance Co., 17325 Euclid Ave., Cleveland 12, Ohio.

BUSINESS NOTES

## Sales Offices Opened

Sales Offices for the Wolverine Tube Div. of Calumet & Helca, Inc., 1852 Guardian Bldg., Detroit, Mich., have been opened in Kansas City. The new offices, Room 208, Broadway-Westport Bldg., 4050 Broadway, Kansas City, Mo., will become sales headquarters for sales representative Thomas E. Goodyear.

## Merger of Parkersburg-Aetna Corporation

Operations of The Parkersburg Rig & Reel Co. and Aetna Ball & Roller Bearing Co. will be consolidated, and the merged company will formally take Parkersburg-Aetna Corp. as its new name.

Parkersburg's plant facilities are located in Parkersburg, W. Va., Coffeyville, Kan., Houston, Tex. and Pomeroy, Ohio, the latter a foundry. Aetna's plant is in Chicago.

## Vibration Engineering Service

Formation of a special vibration engineering service department has been announced by The MB Mfg. Co., Inc., New Haven, Conn., producers of vibration test and control equipment.

This new department will check out MB vibration test equipment in the field and service it under terms of the equipment's warranty. It will also assist designers, test and research engineers in the application of MB vibration exciters for vibration testing to military specification, for fatigue testing and for calibration of vibration pick-ups.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

## Enlarge Terre Haute Facilities

Allis-Chalmers Mfg. Co., Milwaukee 1, Wis., announces the completion of plans to enlarge the manufacturing facilities at its Terre Haute, Indiana, Works. The additional 84,000 sq ft will give facilities to manufacture component parts for transformers, switchgear and circuit breakers the majority of which are presently sub-contracted.

## New Development Company Formed

Formation of a new corporation, Scaife Development Co., a fully-owned subsidiary of Scaife Co., of Oakmont, Pittsburgh Dist. Pa., was announced.

The new organization is the exclusive licensing agent in the United States for an improved hot extrusion process which is a modification of the Ugine-Sejournet tube extrusion process using glass as lubricant. Patent rights are held by the French firm, Comptoir Industriel D'Etirage et Profilage de Metaux, Societe Anonyme.

It makes possible hot forming of cylindrical shapes in all forgeable materials and offers advantages particularly in shapes and materials heretofore considered difficult to form. The process is expected to be applied to the manufacture of high pressure containers such as compressed gas cylinders and accumulator bottles; to products requiring short tube lengths of closely controlled dimensions such as bearing races and cylinder liners; and to a large class of products including gears and other contoured items that can be made from complicated extruded shapes in ferrous materials similar to those now available in non-ferrous materials.

## New Addition to Gas Meter Plant

Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa. has opened a new 19,000-sq-ft addition to its gas meter plant in DuBois, Pa.

With the opening of the new addition, DuBois has become the nation's largest gas meter manufacturing center.

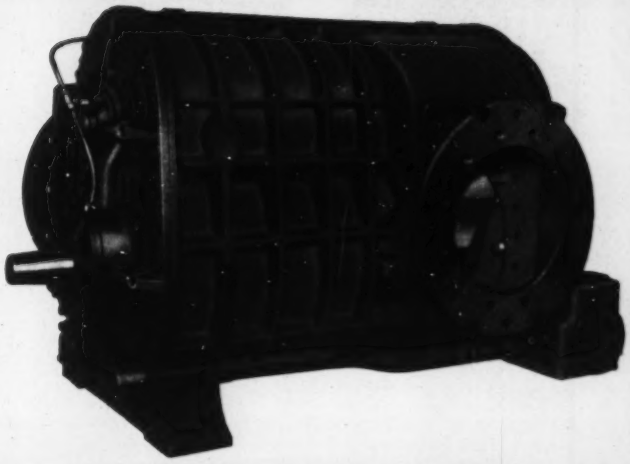
It will house manufacturing facilities for the company's large-capacity industrial gas meters, and is the second Rockwell expansion to be completed in the DuBois area within the past three months.

Additional gas meter manufacturing and storage space was provided by construction of an 11,000-sq ft building at nearby Sykesville, a project completed in mid-September.

Among the new products to be manufactured in the new addition, are Rockwell's lightweight "800" aluminum gas meter and a number of other aluminum domestic and industrial gas meters.

Production of large-capacity gas meters is being transferred from Pittsburgh to the DuBois plant, in order to consolidate the company's gas meter production in one location.


Standardaire® Blower



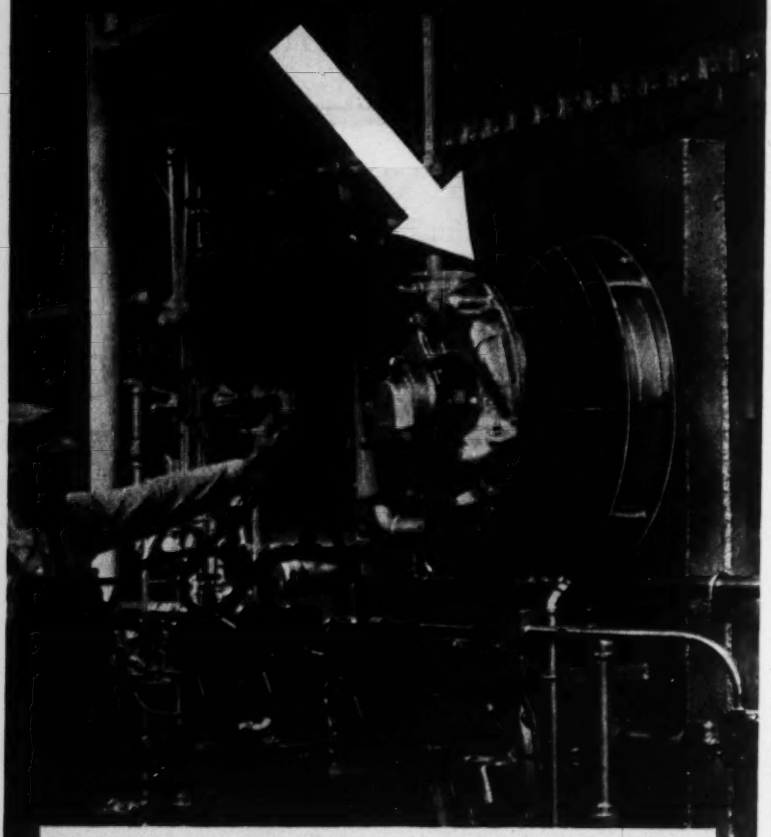
READ STANDARD
CORPORATION

BLOWER-STOKER DIVISION
370 Lexington Ave.
New York 17, N. Y.

It will pay you to investigate the STANDARDAIRE Blower. Write today for further information.

Read Standard also manufactures a complete line of chemical mixers for industrial and laboratory uses.

**Only a WING Axial Flow Turbine Blower would permit such a compact installation**



THIS neat, compact forced draft installation shows how the WING Axial Flow Turbine Blower can save thousands of dollars in installation costs by eliminating the duct work and excavation costs attendant on the use of other types of blowers. This compact, quiet, low-speed blower delivers 11,300 CFM at 3" static pressure to the 40,000 lb. per hr. B & W oil-fired boiler at the Chicago plant of Southern Cotton Oil Co., makers of the well-known Wesson Oil. This is the third Wing blower at the Chicago plant, the tenth in all Southern Cotton Oil plants, the first having been installed in 1916.

Wing

L. J. Wing Mfg. Co.

156 Vreeland Mills Road

Linden, N. J.

*Factories:*

Linden, N. J. and Montreal, Can.

## Open Western Office

Arthur D. Little, Inc., Cambridge, Mass. will open a western regional office in San Francisco early in 1954, announced Dr. Earl P. Stevenson, president of the Company.

## Ryerson Appointed Distributor

Joseph T. Ryerson & Son, Inc., Chicago 80, Ill. steel service organization, is now distributing plastic pipe and fittings produced by the Carlon Products Corp., Cleveland, Ohio, announced J. L. McDermott, manager of the industrial plastics division of the Ryerson company. Service on these products is available through the sixteen Ryerson steel service plants located in major industrial areas across the country.

## Open Detroit Office

To serve one of the nation's largest industrial centers and an increasing number of users of Consolidated Engineering Corporation's broad line of electronic measuring and control instruments in Michigan and Ohio, CEC Instruments, Inc., sales and service subsdiary of the parent firm this month announced the establishment of a Detroit district office. Consolidated Engineering Corp. main office is Pasadena 8 Calif.

## Torrington Expands

The Torrington Mfg. Co., Torrington, Conn., has completed a 48,000 sq ft addition to its facilities for manufacturing fan blades and blower wheels for use by this country's expanding heating, cooling, and ventilating appliance industry.

Subsidiaries in Van Nuys, Calif., and Oakville, Ontario, Canada, have also been expanded to meet the increasing needs of the air-moving appliance industry.

Torrington, which also produces spring coiling machines and auxiliary mill machinery, currently manufactures more than 325 different fan blades and blower wheels for all types of heating, cooling and ventilating units.

## Carborundum Acquires Latrobe Company

Agreement has been reached for The Carborundum Co., Niagara Falls, N. Y., to acquire the capital stock of the Stupakoff Ceramic & Mfg. Co. of Latrobe, Pa.

The Stupakoff Ceramic and Manufacturing Co. will continue operations under its present name and organization. Stupakoff manufactures ceramic and other components used in the electrical and electronic industries. Principal products are tubular ceramic electrical insulators and dielectrics, low loss and precision formed ceramic insulators, ceramic capacitors, ceramic resistors, printed circuits, ceramics with metal attachments, metal-to-glass seals, metal-to-ceramic seals and Kovar metal for sealing to glass.

## Open Chicago Branch Office

Fenwal Incorporated, Ashland, Mass., one of the largest manufacturers of temperature controls and fire detection equipment, announces the opening of its new Chicago district branch office. The office is located at 549 W. Washington St., Rm. 704, Chicago 6.

## South American Piping Contract

The Dravo Corp., 1203 Dravo Bldg., Pittsburgh 22, Pa., has been awarded a contract by the Westinghouse Electric International Co. to furnish all shop fabricated piping for an 8,000-kw turbo-generator and boiler destined for South America. The power generating unit will be installed in the Coltejer steam plant of the Compania Colombiana de Tejedos Fabrica, Bogota, Colombia, S. A.

## New Manufacturing Plant

Kennametal Inc. of Latrobe, Pa. company officials have announced the construction of a new manufacturing plant and office building in the Detroit area. Address of this latest addition to the list of Kennametal's facilities will be 10201 Capital Ave., Oak Park, Mich. This new plant will produce tungsten carbide tools and specialties.

The new plant, together with the necessary stock and equipment, is scheduled for completion on April 1, 1954.

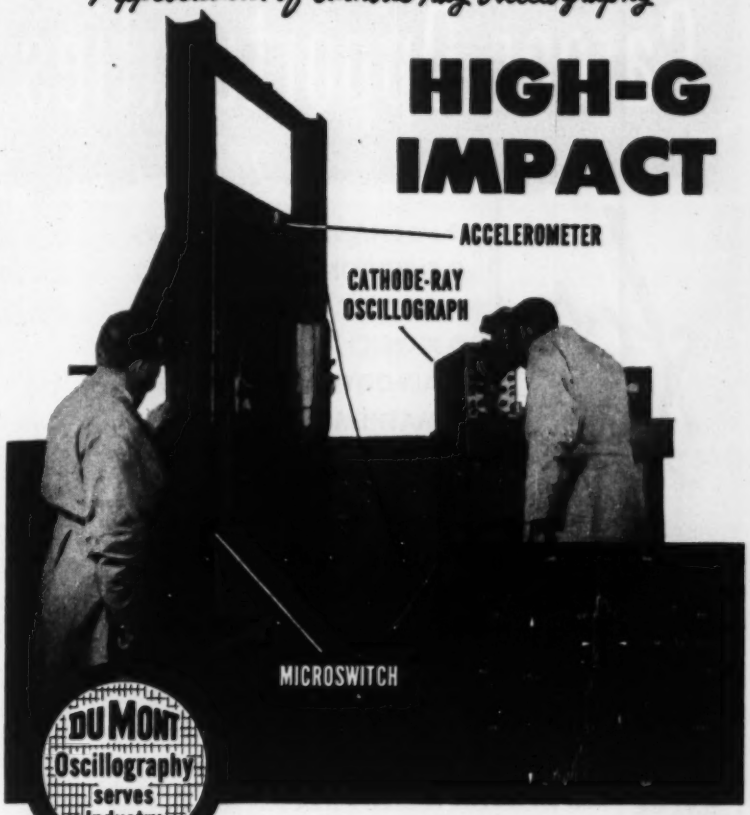
## U. S. Electric Motors Expands

Marking the beginning of an $8,000,000.00 industrial development for Orange County, Cal., ground was broken on the 89-acre site of U. S. Electrical Motors Inc., Los Angeles, Cal., on Santa Ana Freeway in Anaheim.

U. S. Motors operates plants in Los Angeles, Cal., and Milford, Conn. Its principal products are variable speed motors, internally geared motors, explosion-proof and general purpose motors.

*Applications of cathode-ray oscillography*

# HIGH-G IMPACT




The Physical Setup: A bomb-release mechanism holding a dummy bomb is rigidly attached to a metal frame. This assembly can be dropped any preset distance to a solid base bearing a damping material.

The Problem: To measure the deceleration of the mechanism and to prove that it has withstood 25 G for a period of at least 10 milliseconds as required by specifications.

The Solution: A cathode-ray oscillograph* and oscillograph-record camera** are used to record the waveform of deceleration vs. time.

An electrical signal, proportional to deceleration is obtained from a strain-gage-type accelerometer and applied to the Y-axis of the cathode-ray oscillograph. The accelerometer is rated in millivolts per G per d-c volt applied. In this application 750 millivolts corresponds to an acceleration of 25 G for the test conditions set up. The screen of the cathode-ray oscillograph has been calibrated for 1000 millivolts full scale. Therefore, 75 on the scale equals 25 G.

The time axis is an externally-triggered sweep, generated within the cathode-ray oscillograph. The time axis is calibrated by applying the 60-cycle calibrating wave, generated within the cathode-ray oscillograph, to the sweep and adjusting the sweep so that one cycle occupies 3 divisions of the scale. This makes each scale division along the sweep equal to 5 milliseconds. The oscillograph sweep is triggered by a d-c voltage suddenly applied to the external sync post by a microswitch which is tripped by the descending metal frame just before the impact point. A capacitor across the microswitch prevents arcing from getting into the signal leads.

The oscillogram shows that at 75 on the scale, the width of the pulse is more than 2 divisions or 10 milliseconds, and that the test specifications have been met.

An important application of Du Mont cathode-ray instrumentation by Brown and Mole, Inc., Lindenhurst, Long Island.

**DU MONT**
*for Oscillography*

*Du Mont Type 304-A
**Du Mont Type 297

For further information write to:

TECHNICAL SALES DEPARTMENT, ALLEN B. DU MONT LABORATORIES, INC.
780 BLOOMFIELD AVENUE, CLIFTON, NEW JERSEY

# Career Opportunities

for

- MECHANICAL ENGINEERS
- ELECTRONICS ENGINEERS
- ELECTRICAL ENGINEERS
- PHYSICISTS
- AERODYNAMICISTS
- MATHEMATICIANS

Sandia Corporation, a subsidiary of the Western Electric Company, offers outstanding opportunities to graduates with Bachelor's or advanced degrees, with or without applicable experience, in the above fields.

Engineers and scientists at Sandia Laboratory, an atomic weapons installation, work as a team at the basic task of applying to military uses certain of the fundamental processes developed by nuclear physicists. This task requires applied research as well as straightforward development and production engineering.

The place of an engineer or scientist on the Sandia team is determined initially by his training, experience, and talents . . . and, in a field where ingenuity and resourcefulness are paramount, he is afforded every opportunity for professional growth and improvement.

Sandia engineers and scientists design and develop complex components and systems that must function properly under environmental conditions that are much more severe than those specified for industrial purposes. They design and develop electronic equipment to collect and analyze test data; they build instruments to measure weapons effects. As part of their work, they are engaged in liaison with the best production and design agencies in the country, and consult with many of the best minds in all fields of science.

Sandia Laboratory, operated by Sandia Corporation under contract with the Atomic Energy Commission, is located in Albuquerque — a modern, mile-high city of 150,000 in the heart of the healthful Southwest. Albuquerque offers a unique combination of metropolitan facilities plus scenic, historic and recreational attractions; and a climate that is sunny, mild, and dry the year around. New residents have little difficulty in obtaining adequate housing.

Liberal employee benefits include paid vacations, sickness benefits, group life insurance, and a contributory retirement plan. Working conditions are excellent, and salaries are commensurate with qualifications.

**Make Application to:**
**PROFESSIONAL EMPLOYMENT**
**DIVISION B**

**SANDIA** *Corporation*

SANDIA BASE • ALBUQUERQUE, NEW MEXICO

## Move Pittsburgh Office

Golden-Anderson Valve Specialty Co., Pittsburgh, Pa., has moved its general offices to new and larger quarters at 1232 Ridge Ave. The engineering staff has been doubled and production facilities modernized and enlarged to take care of the increased demand.

## Packaged Dehydration Units

J. F. Pritchard & Co., 210 West 10th St., Kansas City 5, Mo., has issued Bulletin No. 16.0.081 covering varied applications and descriptions of "hydryers," packaged dehydration units for efficient drying of air or other gases in all industrial, processing and laboratory installations. Further information on request.

## Strain Gage

The improved Whittemore strain gage is described in a new illustrated two-page bulletin by Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa. Bulletin 4207 gives the features and specifications of this hand type, dial micrometer instrument for 2-in. and 10-in. gage lengths.

## Engine-Type Synchronous Motors

Standard construction features of Allis-Chalmers engine-type, low-speed synchronous motors in ratings of 100 hp and larger at speeds of 450 rpm or less are described in a new bulletin released by the company.

Copies of Bulletin, "Allis-Chalmers Engine-Type Synchronous Motors," 05B8008, are available on request from Allis-Chalmers Mfg. Co., 949 S. 70th St., Milwaukee, Wis.

## Expansion Compensator

A new two-color bulletin describing the new Flexon Expansion Compensator for controlling pipe expansion in low pressure hot water or steam heating systems has been released by Flexonics Corp., Maywood, Ill.

For a copy, write Flexonics Corp., 1305 S. Third Ave., Maywood, Ill., designating Bulletin No. 138.

## Viscosity Measuring System

A system which accurately measures viscosity under industrial conditions is covered in a new technical report, TI 27-A-16b, published by The Foxboro Co., Foxboro, Mass. The equipment consists of a Brookfield Viscometran Viscometer, transmitting electrical measurements of viscosity to a Foxboro Capacity Dynalog Instrument which indicates, records, controls or actuates an alarm.

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

## Compacting Press

Bulletin No. 3101 released by Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa., describes the Model C, a 100-ton powdered-metal compacting press and lists its design specifications.

## Forgings and Castings Handbook

Smooth hammered forgings, composite die sections, and cast-to-shape tool steels produced by the Forging and Casting Div., Allegheny Ludlum Steel Corp., Ferndale, Mich., are described in a new booklet produced by that firm.

The handbook outlines forged shapes available, stainless as well as tool steel, and weight limits, as well as analyses. Information is also included on how to use and order composite die sections to effect substantial tool steel economies and savings in time spent in die making as well. Diagrams of standard shapes are also included.

## Stainless Tubular Products

A new folder, designed to be of assistance to engineers involved in the selection of stainless tubing and pipe for corrosion resistance applications, has been issued by the Tubular Products Div. of The Babcock & Wilcox Co., Beaver Falls, Pa.

Bulletin TDC 160, contains information on the comparative corrosion resistance of stainless steels to corrosive media. It presents pertinent data on six widely used stainless tubing steels and several hundred corrosive media at various temperatures and concentrations.

The Tubular Products Div. of The Babcock & Wilcox Co., with plants at Beaver Falls, Pa. and Alliance, Ohio, manufactures seamless and welded carbon, alloy and stainless steel tubing for all types of pressure and mechanical applications.

Available free at sales offices of the Division at Beaver Falls, Pa.

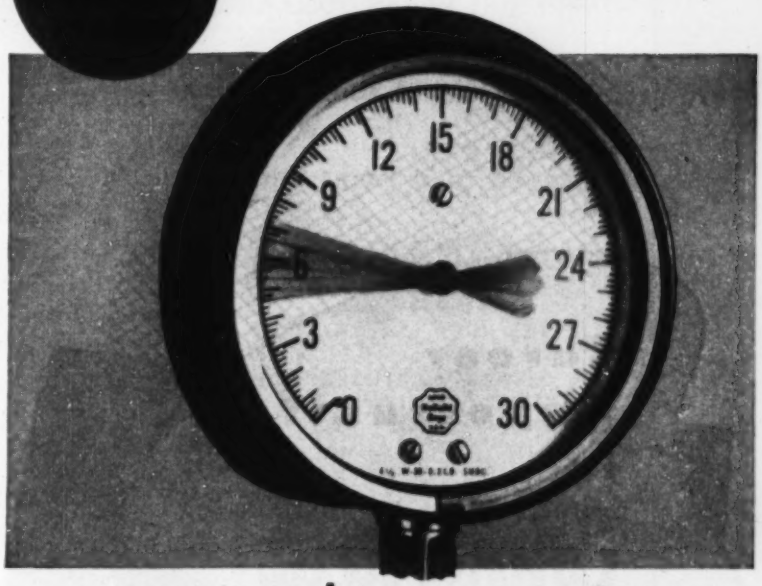
## Fuel Oil Heaters

A new bulletin on fuel oil heaters has been prepared by the Griscom-Russell Co., manufacturers of heat transfer apparatus. It describes two types: the Twin G-Fin Section with longitudinally-finned heat transfer elements, and the Type B Tubular Heater; and explains the details of design and features of both types, with sectional views, illustrations of installations, specifications and dimension tables.

Also included in the bulletin are selection tables for the Twin G-Fin Section for capacities ranging from 50 to 31,000 lb per hr of 10 deg API fuel oil, and the Type B Heater for capacities ranging from 2 to 1,000 gpm of Bunker C fuel oil; with oil to be heated from 100 to 225 F and for pressures from 25 to 250 psig in both tables.

Copies of Bulletin 1415 can be obtained by addressing The Griscom-Russell Co., Wetmore Ave., Massillon, Ohio.


# Helicoid Gages



## are protected two ways against FLUTTER

**HELICOID Gages are designed to withstand many millions of pressure pulsations. Flutter and rapid surges have no effect on their accurate performance in long-life service. Tests show 75,000,000 cycles at 1200 pulsations per minute without wear.**

**1. There are no gears to wear out**

Only HELICOID Gages offer this long-lasting gage movement. There are no gears, no teeth to wear out. Cam wiping action keeps contact points clean and smooth.

**2. Bourdon tubes won't stretch, leak or crack**

Bourdon tubes in HELICOID Gages give maximum torque and minimum stress to promote greatest possible endurance life. Will withstand millions of pressure pulsations without stretching, leaking or cracking.

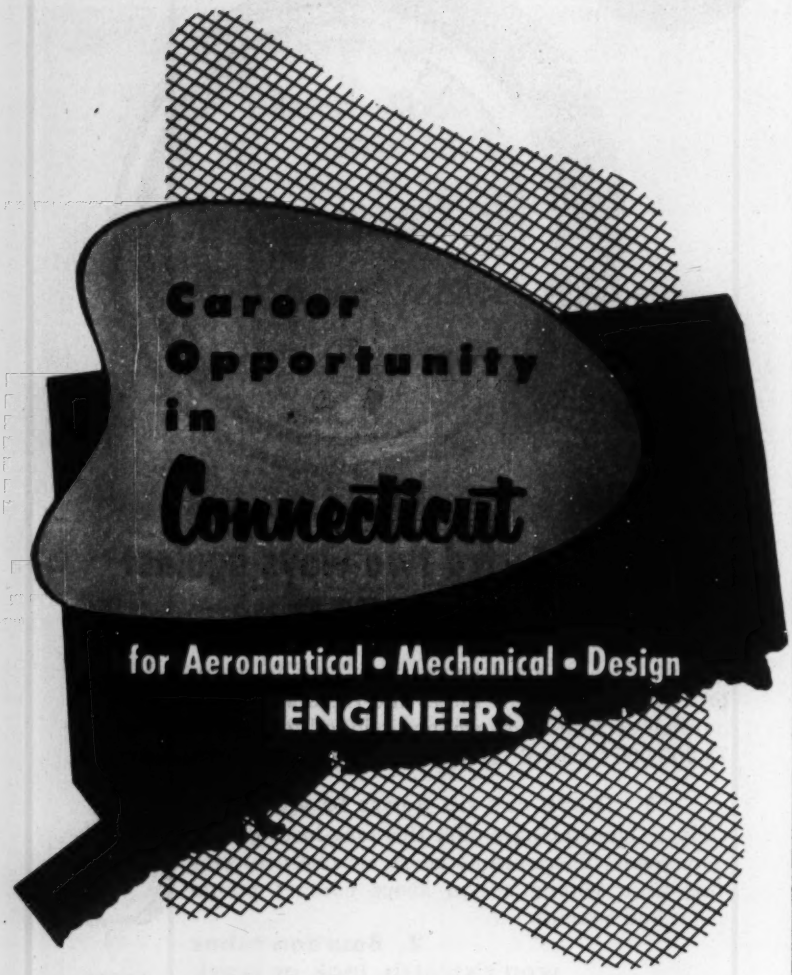
**HELICOID Gages**
**for Pressure, Vacuum or Compound Service**

There are HELICOID Gages for all pressure ranges —with white, black or radiant faces—wall, stem, flush and panel mountings for flangeless cases. See your distributor today or write for **Catalog G-2.**

ACCO

Helicoid Gage Division
**AMERICAN CHAIN & CABLE**

927 Connecticut Avenue • Bridgeport 2, Connecticut




If you want a chance to do *full time engineering*,
a chance to work on challenging assignments,
a chance to build professional recognition —
and if you would like to live in pleasant
New England — *we'd like to hear from you.*
Please send complete resume to
Mr. Paul Smith, Employment Department ME 3.

**PRATT & WHITNEY AIRCRAFT**
Division of United Aircraft Corporation
**East Hartford 8, Connecticut**

## Industrial Products

Johns-Manville has issued a new edition of its 40-page industrial products catalog which offers essential data on the following groups of products: insulations, refractory products, asbestos cement pipe, packings, gaskets, electrical products, frictional materials, roofing, siding, flooring, partitions, and ceilings.

Copies of this "Industrial Products Catalog" are available by writing to Johns-Manville, 22 East 40th St., New York 16, N. Y.

## Hollow-Plunger Control Valves

Hydreco Div. of The New York Air Brake Co., Cleveland, Ohio, has just published a four-page bulletin on Hydreco Hollow-Plunger Control Valves.

The new Bulletin No. 140 explains the Hollow-Plunger Design and other features. A series of three technical drawings graphically illustrate how staggered ports in the valve plunger enable Hydreco valves to provide accurate throttling.

Hydreco single and multiple-plunger control valves are available in capacities of 5 to 80 gpm and for operating pressures up to 2000 psi.


**Two ways you can protect your family against CANCER**

**...a check**
**...a check-up**

Cancer strikes in one of every two families. Each year more than 60,000 American children under the age of eighteen lose a parent to cancer.

Yet many cancers can be cured, if discovered in time.

**Every man should have a complete physical examination once a year. Women over thirty-five should have a complete physical examination twice a year. Patients are being saved today who could not have been saved even a few years ago.**

The American Cancer Society asks your help.

**How soon we find cancer's cause and cure depends on how soon and how much help comes from people like you.**

*Send contribution to Cancer, c/o your local Post Office.*

***Cancer strikes One in Five***
***STRIKE BACK...***
***Give to Conquer Cancer!***

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### Permanent Magnets

Information on the uses, design, properties, and manufacture of Alnico permanent magnets, sintered grade 5, is available in the six-page technical report PM-111, recently issued by Carboloy Dept. of General Electric Co.

### Transmission Belting

A new catalog on rubber transmission belting has been published by The B. F. Goodrich Co., Akron, Ohio. In addition to describing and illustrating construction features of various industrial belts, with recommended usage, the catalog contains special sections devoted to oilproof, textile, lumbermill and agricultural belts.

### Tubing and Pipe for High-Temperature Service

The Tubular Products Div. of The Babcock & Wilcox Co. has prepared a data folder for engineers in the oil-refining and power industries and other fields such as chemical, dye, paper, pulp, beverage, dairy, and food processing industries who are associated with the design of equipment operating at elevated temperatures or pressures. The folder presents condensed technical data on 14 tubing steels used in high-temperature or high-pressure service.

Copies of the six-page folder, TDC 163, are available free upon request to the company's office at Beaver Falls.

### Automatic Power Scoop

Jeffrey Bulletin No. 863 describes a new automatic power scoop designed for one-man operation in unloading bulk material from box cars, produced by the Jeffrey Mfg. Co., Columbus 16, Ohio. The bulletin lists several outstanding features of the scoop, including a "dead-man" switch lever located on the handle grip and a free-wheeling clutch giving the operator full control.

Information on the new automatic power scoop is now available through the company's district offices and distributors in principal cities.

### Combustion Control Case History

A new boiler plant designed for high efficiency, easy future expansion, maximum fuel flexibility, fine appearance, is described in a detailed "Result Story" of A. B. Dick's new $8,000,000 installation in Niles, Ill. Frank M. Donner, Chief Power Engr. at A. B. Dick, points out how this new boiler plant and Hays combustion control enables them to switch fuels easily to obtain high efficiency. Write for Bulletin R-9 Hays Corp. Michigan City, Ind.


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***for Quick Results***



*Everybody knows this sign*

*stands for railroad crossings*

*. . . and smart gear buyers*

*know this sign* CINTI *stands for*

*the best in custom gears.*

CINTI "Gears...Good Gears Only"

THE CINCINNATI GEAR CO. • CINCINNATI 27, OHIO



**WANTED . . .**

**Electrical-mechanical engineer to develop actuating devices.**

One of our clients has an excellent opening for an engineer in the development and engineering of electrical-mechanical devices.

The company is located in Ohio and is the leader in its present fields.

Your experience should qualify you to work with prospects and customers on their problems involving actuation.

If you are a development engineer with a faculty for working smoothly with customers and prospects on unusual jobs, our client would like to know about you. The company offers excellent working conditions, generous profit-sharing insurance and other money benefits, and a chance to grow as the field for actuating devices grows.

Write to:

**Meldrum & Fewsmith, Inc.**
**Attention of Mr. Oliver,**
**Room 300**
**1220 Huron Road**
**Cleveland 15, Ohio**



Over 85% of the torque wrenches used in industry are

STURTEVANT
TORQUE WRENCHES
Read by Sight, Sound or Feel.

- Permanently Accurate
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in inch ounces . . inch pounds . . foot pounds
All Sizes from 0-6000 ft. lbs.

Every manufacturer, design and production man should have this valuable data. Sent upon request.

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THE SUPERIOR BRIDGE DECKING FOR SMALL OR LARGE JOBS

- ★ 80% OPEN
- ★ SELF-CLEANING
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- ★ NOT AFFECTED BY WIND PRESSURE
- ★ LIGHT WEIGHT
- ★ STRONG, SAFE ROAD SURFACE
- ★ MINIMUM OF ROAD MAINTENANCE

IRVING DECKING

"A BRIDGE IS ONLY AS GOOD AS ITS DECK"

- Also gratings for bridge sidewalks and gutter catch basins.
- No accumulation of dirt or snow.
- For further information and engineering data ask for catalog.

IRVING SUBWAY GRATING CO., INC.
ESTABLISHED 1902

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KEEP INFORMED — NEW EQUIPMENT, BUSINESS NOTES, LATEST CATALOGS

## Celite Diatomite Filter Aid

Johns-Manville has just issued a new illustrated eight-page brochure on the use of Sorbo-Cel, a specially treated Celite diatomite filter aid for removing emulsified oil from condensate or process water.

The brochure tells how Sorbo-Cel works, describes types of filters used, and includes step-by-step directions on the operation of a Sorbo-Cel filtration system.

Power engineers and others in process plants where oil-contaminated water presents problems may secure copies of the "Sorbo-Cel Filtration" brochure by writing to Johns-Manville, 22 East 40th St., New York 16, N. Y.

## Sigma Formation in Alloys

"Sigma Formation and Its Effect on the Impact Properties of Iron-Nickel-Chromium Alloys," Bulletin A-154, 14 pages, with graphs and tables, is a study of a brittle, metallic compound likely to occur in high chromium ferrous alloys. Presence of as little as 5 per cent may cause serious embrittlement, the bulletin says. Sigma boundary limits are established for some commercial austenitic alloys containing 20–35 per cent Ni and 15–30 per cent Cr. Cast materials and annealed and moderately cold-worked wrought materials were investigated after exposure at 1200–1650 F from 100 to 3000 hr. Copies are available from International Nickel Co., Inc., New York 5, N. Y.

## Oil and Gas Burning Equipment

A new 28-page catalog with reference material on industrial oil and gas burner equipment has just been issued by The Engineer Co. It includes principles involved in selection and application of various types of burners for utilizing oil or gas or a combination of the two for either standard range or wide capacity range operation, in combination with several kinds of air registers and a wide variety of fuel oil heating and pumping sets. It also has a conversion table showing approximate relationships between quantity of oil burned, boiler capacity and air required for combustion.

Copies sent upon request to The Engineer Co., 75 West St., New York 6, N. Y. Ask for Bulletin OB-53.

## New Hot Water Storage Heater

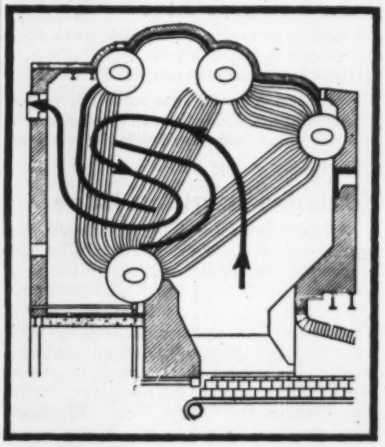
A new 48-page catalog, offered by The Patterson-Kelley Co., Inc., pictures and describes the complete line of P-K hot-water storage heaters and presents useful information on piping arrangements and installation data. Piping diagrams are given for high and low pressure steam systems. Also included is a step-by-step guide for setting up and connecting a storage heater.

A copy of this Catalog, No. 18, may be obtained by writing, on your letterhead, to The Patterson-Kelley Co., Inc., 390 Warren St., East Stroudsburg, Pa.

These important fuel-saving, maintenance-reducing features are obtainable with Enco boiler baffles — *and only with Enco baffles.*

- Streamlined gas flow
- Uniform gas flow
- Elimination of bottle necks
- Reduced draft losses
- Higher heat transfer
- Cleaner heating surfaces
- Less use of soot blower
- Special provision for expansion
- Easy tube replacement
- Adaptable to any water-tube boiler, fired by any fuel

*Each application is designed on the basis of more than a quarter century of experience in this specialized branch of power engineering. Installations are made by skilled mechanics.*



THE ENGINEER CO.
Enco 75 West St. New York 6, N. Y.

DOW CORNING

# Silicone News

No. 5 of a Series • PUBLISHED BY DOW CORNING CORPORATION, MIDLAND, MICHIGAN

## New Data Reveals Effect of Heat Aging on Properties of High Temperature Laminates

Comparative studies of the effect of heat aging on light weight structural materials indicate that the better resin bonded glass laminates compare very favorably with light metals at high temperatures. These studies made recently by our engineers and summarized below in Table I show that the laminates have greater tensile strength than the metals at 500 F after aging for as little as half an hour at that temperature.

Tensile strength to weight ratio for the laminates is also superior to that of the metals under the same conditions. Measured at 500 F after 200 hours at that temperature, the tensile strength to weight ratio times $10^{-2}$ for the silicone-glass laminates is in the range of 4 to 5 times comparable values for the light metals.

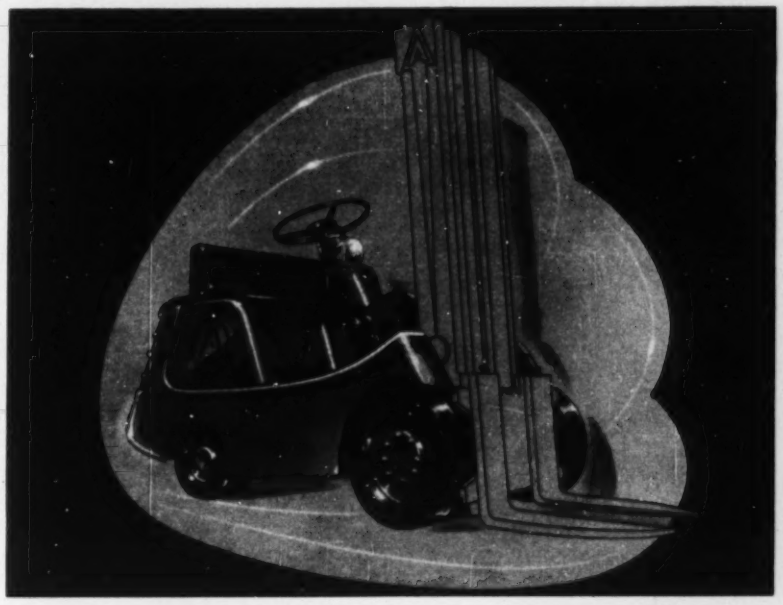
The organic resin bonded glass laminates show excellent short term retention of mechanical strength at 500 F. Strength falls off quite rapidly, however, with increasing time. The mechanical properties of the silicone-glass laminates at 500 F decrease during the first half hour and then improve or remain unchanged with increasing time. Weight loss, water absorption and dielectric properties of the silicone-glass laminates are markedly superior.

Included in this study were glass laminates bonded with several new, heat resistant low pressure phenolic, polyester and

(continued pg. 2)

**TABLE I**
**EFFECT OF HEAT AGING ON HIGH TEMPERATURE LAMINATES AND LIGHT METALS**

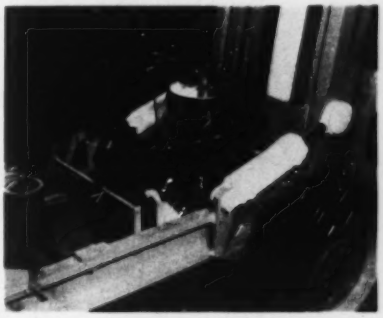
| Property | High Pressure Silicone | Low Pressure Silicone | Low Pressure Polyester | Low Pressure Phenolic | Aluminum | Magnesium |
|---|---|---|---|---|---|---|
| Flexural Strength, psi | | | | | | |
| As received | 45-47,000 | 27-32,000 | 45-55,000 | 44-66,000 | | |
| At 500 F after | | | | | | |
| ½ hr at 500 F | 5,000 | 12-15,000 | 35,000 | 41-50,000 | | |
| 200 hr at 500 F | 19,000 | 12-15,000 | 11-25,000 | 9,000 | | |
| Tensile Strength, psi | | | | | | |
| As received | 26-32,000 | 35,000 | 33-36,000 | 22-27,000 | 50-65,000 | 39-42,000 |
| At 500 F after | | | | | | |
| ½ hr at 500 F | 8-10,000 | 22-25,000 | 30-33,000 | 24-29,000 | 7-13,000 | 8,000 |
| 200 hr at 500 F | 18-20,000 | 20-22,000 | 9,200 | 11-15,000 | 5-9,500 | 6,000 |
| Density, g/cc | 1.65-1.80 | 1.70-1.85 | 1.65-1.85 | 1.50-1.80 | 2.7 | 1.76-1.80 |
| Tensile Strength to Weight ratio x $10^{-2}$ | | | | | | |
| ½ hr at 500 F | 5.3 | 13.6 | 18.0 | 16.1 | 3.7 | 3.5 |
| 200 hr at 500 F | 11.0 | 12.2 | 5.3 | 7.9 | 2.7 | 3.3 |
| Weight Loss, percent 200 hr at 500 F | 0.35-1.31 | 0.1-0.2 | 9.00 | 11.2 | | |
| Water Absorption, percent (After aging 200 hr at 500 F) | 0.21 | 1.0-1.3 | 2.00 | 9.00 | | |
| Dielectric Strength, v/m, ⅛" electrodes | | | | | | |
| As molded | 80-100 | 300 | 90 | 200 | | |
| Aged 200 hr at 500 F | 80-100 | 80-100 | 70 | 60 | | |
| Power Factor, percent As received, at $10^{6}$ cps | 0.14 | 0.22 | 1.2 | 2.7 | | |
| Dielectric Constant As received, at $10^{6}$ cps | 3.90 | 4.13 | 4.00 | 4.31 | | |
| Arc Resistance, sec. As received | 300 | 350 | 185 | 165 | | |



## Designers Use Class H Insulation to Sell More Electric Machines in Buyer's Market

Instead of viewing with alarm our entry into a more normal competitive economy, Automatic Transportation Company has prepared for it. They have developed a new product with many strong selling features, including more continuous operation with minimum maintenance cost.

"Dynamotive", Automatic's newest entry in the materials handling equipment market, has so many new features that it bears little resemblance to the lift truck of 5 or 10 years ago. The first gas-powered, electrically driven fork lift truck, it has an electrical system that assures long service life by making it impossible to reverse the direction of the truck while it is in motion.



Engine wear and fuel consumption are minimized by an electrical transmission with its inherent overdrive feature that

(continued pg. 2)

# DOW CORNING Silicone News

## NEW DEVELOPMENT AND TECHNICAL DATA

*For copies of any of the publications reviewed in this column or for data relating to any of the articles printed in this issue of the Dow Corning Silicone News, simply circle the corresponding reference number on the coupon below.*

**Silicones have captured the interest of imaginative designers. And it's not all idle thinking because the properties of these unique materials enable engineers to effect their ideas in new products and applications. A reprint of a recent BUSINESS WEEK article reviews some of the existing uses for silicones and forecasts many new silicone products for the industrial and consumer markets.** *No. 44*

●

**The use of bare magnet wire insulated with Dow Corning Wire Enamel makes possible longer life, increased reliability and reduction in size and weight of electronic devices, fractional and miniature motors. Accelerated tests at temperatures in the range of 200 to 275 C indicate its long term serviceability at temperatures up to 190 C (374 F.) A list of electrical wire manufacturers, who make such wire available in various sizes, is yours for the asking.** *No. 45*

●

**New source of supply list names more than 60 formulators supplying durable protective coatings made with silicone vehicles. Available coatings include white and colored silicone appliance enamels that withstand temperatures up to 700 F; aluminum pigmented finishes which minimize maintenance of exhaust stacks exposed to corrosive atmospheres and temperatures up to 1000 F; and modified silicone-organic paints that offer increased stability, greater resistance to temperature extremes, weathering, oils and greases.** *No. 46*

●

**The 1954 Reference Guide to Dow Corning Silicone Products summarizes properties and briefly describes applications for commercially available silicones including several new products. Containing a wealth of useful information about silicone products, the Guide belongs in every designing and engineering reference file.** *No. 47*

●

**Reprint of a recent article "Silicones In Packaging" describes how various silicones are used to advantage in handling, processing and packaging drugs and pharmaceuticals, baked goods, foods and beverages.** *No. 48*

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**DOW CORNING CORPORATION - Dept. 01-15**
**Midland, Michigan**

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# New Silicone Coating Prevents Adhesion and Build-up on Rolls, Slashers and Drying Cans

A recently developed silicone product called Dow Corning XF-121, is proving to be a highly effective and economical coating for rolls, slashers, and drying cans used in the textile industry.

Properly applied, Dow Corning XF-121 forms a tough, resilient film which reduces the adhesion and minimizes build-up of such warp or sizing materials as starch, gelatin, synthetic rubber latices and styrenated resins. On high production units, only thin coatings are required to reduce scrap due to build-up, and to substantially reduce down time and maintenance costs.

Dow Corning XF-121 can be applied without dismantling equipment. Cost is only about 1% of the cost of the only other coating now available that gives comparable performance. In most applications, less than 4 pounds of Dow Corning XF-121 will cover 100 square feet of roll area. Reports indicate that even such thin coatings provide several weeks or months of service, depending on operating conditions. Production increases up to 50% have also been reported.

Supplied as a solvent solution with a 25% silicone content, Dow Corning XF-121 can be applied as received, or it can be thinned with additional solvent and applied by brush or spray. Properly catalyzed, it will air dry and cure overnight or it may be cured by heating for 1/2 to 1 hour at 200 F. The film is easily removed with a wide spatula or putty knife.

*No. 41*

### DESIGNERS USE CLASS H *(continued)*

automatically adjusts engine speed to load requirements. The engine and motor always run at the most efficient speed.

And to obtain still longer, more dependable service life, the generator and motor of the "Dynamotive", like all Automatic motors built since 1946, are protected with Class H insulation made with Dow Corning silicones. Automatic Transportation engineers report that: *"silicone insulation is used because it contributes to longer life and can take more abuse than other insulating materials. Since we adopted it over 7 years ago we have never, to our knowledge, lost a motor due to insulation failure."*

That's the kind of performance that has sold more and more electrical equipment manufacturers and their customers on the value of silicone (Class H) insulation They know from experience that Class H can be used to increase the power per pound ratio in electric machines by at least 50% without loss of efficiency. And, even more important in a buyer's market, they know that Class H outlasts ordinary insulation 10 to 1. *No. 42*

### EFFECT OF HEAT AGING *(continued)*

silicone resins. The high pressure, silicone-glass laminate specified under NEMA Grade G-7 (LPI-1951) and MIL-P-997B was selected as a standard of comparison.

Style 181 glass cloth, heat treated for the silicone resins and Garan finished for the organics, was used for all laminates. Test samples were cut from 1/8" sheets which had been cured according to the resin manufacturers' recommendations.

High pressure silicone-glass laminates were press cured at 350 F followed by a graduated cure in an oven at temperatures ranging from 194 to 392 F for a total of 24 hours. The low pressure silicone-glass laminates were aftercured for 150 hours at 482 F.

The tests included in this study were conducted according to Fed. Spec. L-P-406b. Flexural and tensile strengths were measured at test temperatures. Water absorption, dielectric strength and weight loss were measured at room temperature after aging for 200 hours at 500 F. Arc resistance, power factor and dielectric constant were measured at room temperature after curing.

*No. 43*


DOW CORNING CORPORATION

*First in Silicones*

Atlanta
Chicago
Cleveland
Dallas
Detroit
**MIDLAND, MICHIGAN**
Los Angeles
New York
Washington, D. C.
(SILVER SPRING, MD.)

In Canada: Fiberglas Canada Ltd., Toronto
In England: Midland Silicones Ltd., London

Manufacturers of
Silicone Fluids
Silicone Abhesives
Silicone Adhesives
Silicone Release Agents
Silicone Compounds
Silicone Greases
Silicone Water Repellents
Silicone Bonding Resins
Silicone Electrical Insulating Resins
Silicone Molding Compounds
Silicone Expansible Resins
Silicone Defoamers
Silastic

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

## Applications of Thermostatic Bimetals

A new 36-page illustrated booklet describing and explaining 22 uses of bimetal as actuating elements in temperature responsive devices manufactured by customers of the W. M. Chace Co., and ten pages of engineering data for element design and selection is available from W. M. Chace Co. 1619 Beard Ave., Detroit 9, Mich.

## Bearing Selection

Basic technical data, facilitating selection of the proper bearings for any installation, feature the new Catalog 61, descriptive of Torrington heavy duty needle bearings manufactured by The Torrington Company's Bantam Bearings Div.

Copies of Catalog No. 61 are available upon letterhead request to The Torrington Co., Bantam Bearings Div., South Bend 21, Ind.

## Consumable-Electrode Gas-Shielded Welding

Three new bulletins on the recently developed Fillerarc consumable-electrode gas-shielded welding process have been announced available from the General Electric Co., Schenectady 5, N. Y.

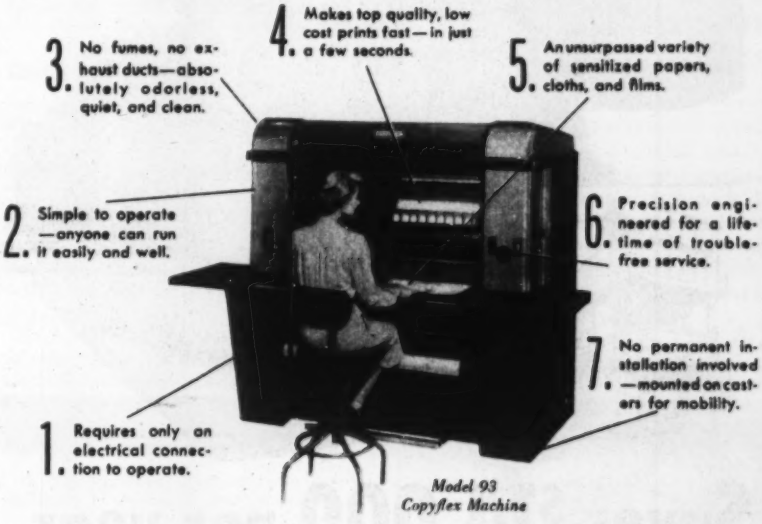
An eight-page publication, designated GER-819, is a reprint of a paper presented before the American Welding Society by R. W. Tuthill of the GE Welding Dept. It contains information on the developments and experiments undertaken in the design and manufacture of the equipment.

## Positioner for Cylinder-Operated Devices

Bulletin 473, issued by The Foxboro Co. of Foxboro, Mass., describes the Poweractor, a new force-balance type positioner for cylinder-operated devices. Designed especially for use with the Foxboro Stabiload Cylinder, Foxboro says the Poweractor unit will position equipment requiring high power and long stroke, such as large-size control valves, large dampers, and variable speed drives, through pneumatic-cylinder (or springless-diaphragm) operating mechanisms.

Discussed in detail are Poweractor unit characteristics and operation. Specifications are given, along with data on applying the positioner to specific control problems. Copies of Bulletin 473 will be sent on request.

# Seven Good Reasons for Specifying Copyflex for Your Next Copying Machine


3. No fumes, no exhaust ducts—absolutely odorless, quiet, and clean.
4. Makes top quality, low cost prints fast—in just a few seconds.
5. An unsurpassed variety of sensitized papers, cloths, and films.
2. Simple to operate—anyone can run it easily and well.
6. Precision engineered for a lifetime of trouble-free service.
7. No permanent installation involved—mounted on casters for mobility.
1. Requires only an electrical connection to operate.

*Model 93 Copyflex Machine*

Why settle for less when it costs no more to own the one machine that offers *all* the benefits of diazo type, positive black-on-white reproduction?

That's what you get with a Bruning Copyflex. You have all the speed, the economy, and the quality associated with positive black-on-white reproduction . . . plus problem-free installation, ease of operation, and absence of fumes, exhaust ducts, ventilating fans, and similar drawbacks.

Today's Copyflex machines represent 25 years of development by men who are thoroughly familiar with engineer prints and print-making requirements. They are made by the Charles Bruning Company, who introduced the diazo type direct process of reproduction in this country in 1929.

There is a Bruning Copyflex that will exactly fit your requirements. Write us for full particulars.

BRUNING Copyflex

Copies anything typed, written, printed or drawn on ordinary translucent paper—in seconds.

CHARLES BRUNING COMPANY, INC. • 4700 MONTROSE AVENUE • CHICAGO 41, ILLINOIS

*Everything for the Engineer and Draftsman*

# Saves $14,000 per year

## How Woodall Industries Uses Pangborn to Reclaim Wood Dust for Fuel

Mass production of made-to-order Masonite parts means mass production of dust and fine shavings as hundreds of parts per hour are sawed, punched, sanded, molded, drilled and shaped from sheets of Masonite. But Woodall Industries, Inc. put this scrap to work in its Mineola, L. I. plant with the help of a Pangborn dust collection system.

All this dust generated in processing is collected, transported to bins and then burned as fuel — providing all the fuel for both heat and processing requirements. In just one year, Woodall estimates that the savings amounted to over $14,000 in fuel alone —plus additional savings in plant maintenance costs. Employee health and morale, too, gain from this Pangborn-planned program of dust control.

**Pangborn Corp., 2200 Pangborn Blvd., Hagerstown, Md.**

**How Much Can Pangborn Dust Control Save You?**

Pangborn engineers are ready to discuss *your* Dust Control problems — large or small, and show you how Pangborn equipment can save you time, trouble and money. Write your name and company address on the margin of this ad and mail in today for a no-obligation discussion.

**Pangborn DUST CONTROL**

*STOPS THE DUST HOG FROM STEALING PROFITS*

PANGBORN'S 50TH ANNIVERSARY • 1904-1954


KEEP INFORMED — NEW EQUIPMENT · BUSINESS NOTES · LATEST CATALOGS

### Steel-Weld Fabrication

The R. C. Mahon Co., 6565 E. Eight Mile Rd., Detroit 34, Mich. engineers and fabricators of steel in any form have issued a well colored illustrated brochure which sets forth the Steel-Weld fabrication of massive bases, frames, mounts and numerous other heavy machinery parts and assemblies, previously produced in casting form. This brochure presents illustration and description of the many products fabricated, pointing up precision and workmanship.

Brochure may be obtained by writing Company.

### Specialized Instruments

A new condensed bulletin has been published by F. W. Dwyer Mfg. Co., 317 S. Western Ave., Chicago 12, Ill., presenting the company's broad line of specialized instruments and gages. Included are instruments for accurate measurement of combustion, draft, pressure, flow, vacuum, $CO_2$, smoke, velocity, static pressure, pressure differential, temperature and other similar studies. Each type is illustrated and clearly described. Write for Dwyer specialized instruments and gages.

### Rubberized Abrasives

The adaptability, versatility and application of Cratex rubberized abrasives, together with complete specifications and prices is the content of the new Cratex Catalog No. 53. It contains a most complete and comprehensive treatise about rubberized abrasives on burring, smoothing and polishing operations and their use in industrial establishments.

They are manufactured in wheels, points, blocks, sticks and cones for machine or manual application in four standard "grit-types" ranging from relatively coarse to extremely fine textures, for use on hard or soft metals, plastics, ceramics and other materials.

The new Catalog No. 53 is available free from Cratex Mfg. Co., 81 Natoma St., San Francisco 5, Calif.

### Batch Furnace

A new bulletin on the "Allcase" batch type controlled atmosphere furnace has just been released by Surface Combustion Corp.

It is a six-page illustrated folder that completely describes the features of the standard and heavy duty sizes of this radiant tube heated furnace. Equipped with a recirculating fan and an enclosed quench it can be used for all types of controlled atmosphere steel treatments. Included in this bulletin are detailed construction drawings and photographs of typical process applications.

For copies of Bulletin SC-163 write directly to Adv. Dept., Surface Combustion Corp., Toledo 1, Ohio.

## Heating Boilers and Steam Generators

A four-page bulletin, Form AD-109, covering the Cleaver-Brooks line of tank-car heaters, bituminous boosters, Peak-Temp oil boosters, Deuce combination tank-car heaters and pumping boosters, and mobile, portable, and stationary boilers, has been issued by the Cleaver-Brooks Co., Milwaukee, Wis.

## Heat Pump

A new all-electric Heat Pump is described in a four-page bulletin available from the Westinghouse Electric Corp.

The Heat Pump is the completely self-contained system that—without water or flame—provides warm filtered air in winter and cool, dehumidified air in summer.

A complete explanation of the heating and cooling cycles of the unit is presented in the bulletin including schematic flow diagrams of the refrigerant and air.

For a copy of this Heat Pump bulletin, write Westinghouse Air Conditioning Div., Dept. T-557, 200 Readville St., Hyde Park, Boston 36, Mass.

## New Electronic Balancing Machines

The Electrodyne, a new principle for automatically measuring the amount and indicating the angular location of unbalance by means of electronics, is comprehensively described in Bulletin 49 just released by Tinius Olsen. In addition, the bulletin describes features of the complete line of Olsen Electrodyne dynamic and static balancing machines including the horizontal and vertical models as well as the automatic crankshaft balancer.

Copies of Bulletin 49 are available upon request to the Tinius Olsen Testing Machine Co., 3061 Easton Road, Willow Grove, Pa.

## Industrial Water Conditioning

The 4th edition of the Betz Handbook of Industrial Water Conditioning offers a practical up-to-date text for reference or study. The introductory chapters deal with basic water treatment processes such as aeration, coagulation, softening, etc. The following chapters are concerned with specific water problems, particularly problems encountered in boiler water and cooling water conditioning. Applications and limitations of various water-treating equipment and methods are covered in detail.

To guide plant engineers and chemists in handling and supervising water conditioning operations, a supplementary section of the handbook is devoted to control water analyses and their interpretation.

It is for engineers and chemists working directly with water problems, also for management executives, consultants and others concerned in some degree with water conditioning in industrial plants. Price: $3.00 (postage prepaid). W. H. & L. D. Betz, Gillingham & Worth Sts., Philadelphia 24, Pa.

## Adjustable-Pitch Fan

Adjustable-pitch fans for cooling tower, heat exchanger and mine use are described in Bulletin A-111, a new publication of the Hartzell Propeller Fan Co., Piqua, Ohio.

The Hartzell line of adjustable-pitch fans includes 10 ft to 22 ft diameter models with Hartzite (fabric-base) plastic blades and welded steel hubs and 40 in. to 103 in. diameter models with cast-aluminum alloy blades and hubs.

Copies of the new bulletin may be secured by writing to the Hartzell Propeller Fan Co., Piqua, Ohio.

## Stainless Steel Booklet

A new booklet describing the uses of Allegheny Metal Stainless Steel in the paper industry has been published by Allegheny Ludlum Steel Corp. It includes descriptions indicating where stainless is used in the pulp and paper industries plus detailed information on the technology of Allegheny Metal. A special stainless finder for use in the paper industry analyses the types of stainless available on the basis of comparative properties.

Copies are available by writing to the Advertising Dept., Allegheny Ludlum Steel Corp., 2020 Oliver Building, Pittsburgh 22, Pa.

## Packaged Automatic Boiler

A four-page folder describes Powermaster packaged automatic boilers in seventeen sizes from 15 through 500 hp for steam process as well as steam and hot water heating service. The bulletin describes the advantages of packaged automatic boilers. Outstanding constructional and operational advantages of Powermaster, 3-pass design, forced draft, automatic controls, are described and pictured. The firing equipment for light and heavy oils as well as gas is described in the Voriflow air-atomizing oil burner and pre-mix gas burner designs. Write Orr & Sembower, Inc., Morgantown Rd., Reading, Pa., for a copy without obligation.

*Additional Opportunities for positions are offered among the display advertisements on pages*

*58, 64, 66, 67, 75, 126*

MODERN PLANTS HAVE MODERN SKYLIGHTS OF
SHATTERPROOF
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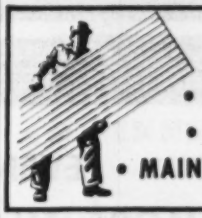
TRANSLUCENT
STRUCTURAL PANELS



WHY?
• LOWEST COST
• BETTER LIGHT
• MAINTENANCE FREE

Skylights of Resolite are installed at half the cost of conventional glazing because Resolite nests with all standard corrugations; requires no framing or flashing. It rests on the same members, is fastened the same way as the metal sheets. Sidewall lights of Resolite in non-corrugated construction need no expensive sash, simple angle girts give full support.

Shatterproof, structurally rugged, inert to usual industrial fumes, Resolite has unlimited life without protective treatment or maintenance. It is a quality product composed of stable polyester resins, reinforced with a *two-ounce* Fiberglas mat. It can be sawed, nailed, bolted and installed with ordinary tools by unskilled workers.

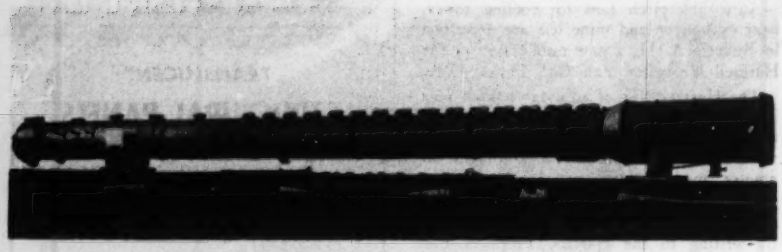
Flat sheets for sash are factory-cut to size. They are installed like glass.

The pictures above show the even distribution of daylight obtained in a building skylighted and glazed with Resolite. Its diffused light gives workers greater visual comfort . . . cuts artificial light costs. See why more and more nationally known industries are using Resolite for modern plant daylighting.

Send for New Industrial Skylighting Folder and Name of Nearest Distributor

RESOLITE CORP.
BOX 502 ZELIENOPLE, PA.

# THIS TOWER IS 123 FEET LONG 6 TO 8 FEET DIAMETER*



## EVEN SO, THERE'S MORE THAN MEETS THE EYE

. . . although the size of this particular job is impressive, it's what doesn't meet the eye, that makes the difference. The important element on this or any DOWNINGTOWN job of carbon steel and alloy plate fabrication is their ability to produce quality products of Correct Design, Right Materials, with Skilled Craftsmen . . . at a Fair Price.

Let DOWNINGTOWN's experience and research in the fabrication of various grades of Carbon Steel, Stainless Steels, Nickel-Clad, Stainless-Clad, Monel-Clad, Nickel, Aluminum, etc., be of help to you. We are equipped with modern facilities to handle jobs, (within our limitations) in the correct alloys and with methods of fabrication required to assure satisfactory operation. DOWNINGTOWN has a Heat Transfer Division under the direction and supervision of men thoroughly trained and experienced in this field. Engineering Consultation with them is at your service to aid you in preparation of plans and specifications for definite jobs.

Useful literature gladly sent upon request. Remember: "your Plate Fabrication or Heat Exchanger needs are our specialty!"

* This Tower 8'0" dia., large end tapering to 6'0" dia. Total length is 123'7". Tower equipped with 55 trays, each Tray fitted with 86 Riser Pipes, Bubble Caps, etc. Thickness of shell and Head is ¾" and ⅜" carbon steel, respectively.

In addition to information on manufacturing equipment, welding procedure qualifications, and typical examples of plate and heat exchanger fabrication, a partial analysis of the 1950 ASME Code for Unfired Pressure Vessels and a few comparisons with the 1949 Code are included in a bulletin which will be mailed on request. Write for your copy today.

NEW YORK OFFICE: 30 CHURCH ST.

DOWNINGTOWN IRON WORKS, INC.
DOWNINGTOWN-PENNA.
DIVISION OF PRESSED STEEL TANK COMPANY
STEEL AND ALLOY PLATE FABRICATION AND HEAT EXCHANGERS

### Inch-Gram Torque Wrench

The P. A. Sturtevant Co., exclusive manufacturer of torque wrenches and associated products, introduces a new standard model torque wrench, the F80-I-G, 0 to 80 inch-gram range, believed to be the lowest capacity instrument of this type ever offered.

These torque wrenches are designed for use in the electronics, instrument and precision equipment field and are ideally suited for applications requiring special torque testing fixtures.

Write the P. A. Sturtevant Co., Addison, Ill., for complete details and assistance with special torque problems.

### Temperature and Pressure Relief Valves

A new publication entitled "Your Handbook on Temperature and Pressure Relief Valves" explains and illustrates the function of relief valves, both temperature and pressure, insofar as water heaters, industrial and domestic, are concerned.

It touches on both American Gas Association and ASME code requirements, and it also presents recommended code requirements for cities, inspectors and plumbers. The pamphlet also lists twenty-five "do's and don'ts" for relief valve users.

For additional information on this subject, write A. W. Cash Mfg. Corp., Decatur 60, Ill.

### Quick Mounting Bracket

The Rakit Corp., 711 S. 50th St., Philadelphia, Pa., has just issued an eight-page catalog describing and illustrating its complete line of quick mounting brackets for the support of cable trough, conduit instrument tubing trough and similar items.

All standard units are represented by photograph, dimensional drawings and brief descriptive matter. Also shown are some of the many ways in which these brackets may be quickly assembled to provide support for a wide range of applications.

Free copies of the Catalog are available upon request to the manufacturer.

### Single-Stage Turbine

A six-page bulletin containing design features, dimensions, and performance data on the new De Laval HCB single-stage turbine has been issued by the De Laval Steam Turbine Co. Maximum operating conditions of the HCB turbine are: horsepower to 100; pressures to 300 psig; temperature to 550 F; speed to 4000 rpm. The bulletin presents a two-page cut-away diagram of the HCB turbine with a descriptive list of 18 design features.

Length and width measurements and dimensions of parts are given in line drawings of the HCB turbine. Other information includes performance data and construction materials. Requests should be sent to De Laval Steam Turbine Co., Trenton 2, N. J. for Bulletin 4206.

**MECHANICAL ENGINEERS** *and* **ELECTRO-MECHANICAL ENGINEERS**

*for Lockheed's expanding Missile Systems Division*

- Recently formed from other Lockheed Engineering organizations to prepare for the era of automatic flight, the Missile Systems Division deals exclusively with missiles and their component systems.
- Its expansion is creating "ground-floor" openings for:

  **Mechanical Engineers**
  with experience in precision mechanisms or packaging of electronic equipment.

  **Electro-Mechanical Engineers**
  with circuit or servomechanisms experience (aircraft or missile experience preferred)

- In addition to outstanding career opportunities, the Lockheed Missile Systems Division offers you high salaries commensurate with your experience, generous travel and moving allowances, and a better life for you and your family in Southern California.

*Address inquiries to L. R. Osgood, Dept. ME-M-3, Lockheed Missile Systems Division, 7701 Woodley Avenue, Van Nuys, California*

**LOCKHEED MISSILE SYSTEMS DIVISION**
**VAN NUYS, CALIFORNIA**


KEEP INFORMED

### Water Columns

New Data Unit No. 232 describes, illustrates, and gives specifications on Jerguson water columns. Principle of operation and features that assure positive alarm signals if boiler water falls too low or rises too high are explained. Jerguson Gage & Valve Co., 80 Fellsway, Somerville 45, Mass.

### Logging Catalog

A new heavy equipment catalog has been announced available from Hyster Co. Featuring Caterpillar-Hyster packaged equipment, the catalog illustrates the use of logging, loading, and road building equipment with on-the-scene operations in different parts of the world. Equipment includes logging arches, winches, yarders, donkeys, earthmoving, loading, and road-building machinery.

The "Packaged-Equipment" catalog, Form 1262 may be had free from Hyster Co., 1800 N. Adams St., Peoria, Ill.; 2902 N. E. Clackamas St., Portland, Ore.; or from any Caterpillar-Hyster dealer.

### Vapor Barrier Book

Complete recommendations for vapor-sealing insulation on low temperature vessels are given in an 80-page edition, bound volume just published by the Insul-Mastic Corp. of America, 1141 Oliver Bldg., Pittsburgh 22, Pa. The book is entitled "Vapor and Weather Barriers for Low Temperature Installations." It contains fifty-four illustrations showing exactly where and how a vaporseal coating should be applied over thermal insulation. The purpose of such a coating is to prevent deterioration of the insulation and rusting of the vessel beneath it due to moisture and moisture vapor.

### Precipitator

The Permutit Co., 330 West 42 St., New York 36, N. Y. issued Bulletin No. 2204B describing their precipitator. This precipitator is said to offer more efficient means for removing impurities from liquids by precipitation, adsorption, settling and upward filtration.

Permutit precipitator units are available in sizes having daily capacities varying from 1000 gallons to any reasonable unit capacity. Precipitator batteries having daily capacities of up to 120,000,000 gallons are in use in various industries and municipalities. Chief applications in the field of water treatment are: water softening; removal of turbidity, color, taste and odor; reduction of alkalinity; removal of silica; removal of iron and manganese. It has been found valuable in boiler feed water conditioning, production of a clear, low alkalinity water for breweries and bottlers of carbonated beverages, for cooling water for petroleum refineries and other industries, for process water in paper mills. It is also used for coagulation and clarification of colored waters and for the removal of iron, manganese and silica in addition to softening.


PPC

*When You Buy*

**Pumps and Compressors**

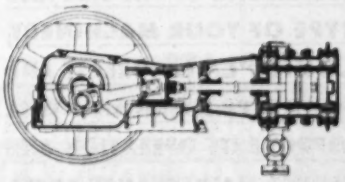
DO YOU WANT | LONG LIFE, EASY MAINTENANCE, RELIABILITY

These Are **BUILT-IN** *By* **PENNSYLVANIA**

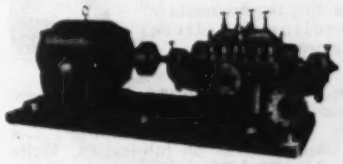
AIRCHEK VALVE

Automatically prevents reverse flow through Compressor and also dampens pipe line pulsations.

This Check Valve should be on EVERY reciprocating Compressor. Bulletin 509-12



OILFREAIR & OILFREGAS Compressors Class ATL with steel-backed carbon cylinder-liners. Guaranteed to compress free of any trace of oil or oily vapors.
Bulletin 600-12



PENNSYLVANIA 4-Stage THRUSTFRE Centrifugal Pump for Boiler Feeding, General Power Plant and Industrial Use.
Bulletin 237-12

YOUR Copy of Catalog 546 briefly describes All PENNSYLVANIA Products. Write For It Today.

**PENNSYLVANIA Pump & Compressor Co.**
**EASTON, PA.**

OILFREAIR® OILFREGAS® THRUSTFRE® AIRCHEK®

"NO SHUT-DOWNS WITH LUBRIPLATE"

—say HENRY & WRIGHT of Hartford, Conn.

"While waiting for delivery of one of our 25-ton Dieing Machines to do a particularly heavy job, a customer was trying to start production of a 10-ton machine. Even though it was lubricated with a conventional grease every eight minutes, the machine had to be shut down for bearings to cool during each coil run. Then, on our recommendation, he changed to a LUBRIPLATE Lubricant. With but two applications of LUBRIPLATE a day, the machine operated continuously except during change of coils."

**REGARDLESS OF THE SIZE AND TYPE OF YOUR MACHINERY, LUBRIPLATE GREASE AND FLUID TYPE LUBRICANTS WILL IMPROVE ITS OPERATION AND REDUCE MAINTENANCE COSTS.**

LUBRIPLATE is available in grease and fluid densities for every purpose... LUBRIPLATE H.D.S. MOTOR OIL meets today's exacting requirements for gasoline and diesel engines.

For nearest LUBRIPLATE distributor see Classified Telephone Directory. Send for free "LUBRIPLATE DATA BOOK"... a valuable treatise on lubrication. Write LUBRIPLATE DIVISION, Fiske Brothers Refining Co., Newark 5, N. J. or Toledo 5, Ohio.

KEEP INFORMED

NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

## Piping and Pressure Vessels

Volume 1, No. 2 of Taylor Forge, issued by Taylor Forge & Pipe Works, P.O. Box, 485, Chicago 90, Ill., contains essential material from the recently approved ASA B16.5-1953, covering pressure-temperature ratings for steel pipe flanges and flanged fittings.

It includes a report by the Task Force on flexibility, ASA Code for pressure piping. Included are comments by participating members of the Task Force and sample calculations. It includes reviews of recent articles, engineering papers and Standards, published since previous issue.

In these contributions to engineers, concerned with piping and pressure vessel work the company makes available the engineering information resulting both from their own research and the work of others.

Copies of this publication may be obtained by writing to the company.

## Heats up Steam Units 8 Times Faster

A new four-page catalog has just been published which tells operators of steam-using units how to bring them up to maximum capacity eight times faster.

This catalog discusses the new Super-Silvertop Heat-Kwik Steam Traps manufactured by the V. D. Anderson Co., which vent air from steam units eight times faster than ordinary inverted bucket traps. The use of these traps enables the user to obtain more production from steam units, lower steam consumption, longer trap life and a reduction in the trap capacity factor.

The folder contains complete buying information on Heat-Kwik Steam Traps—including condensate capacities, sizes, weights, and prices. Other products manufactured by the Steam Specialties Div. of the company are also described.

For a copy of the catalog write for Bulletin 1153, the V. D. Anderson Co., Dept. H, 1935 W. 96th St., Cleveland 2, Ohio.

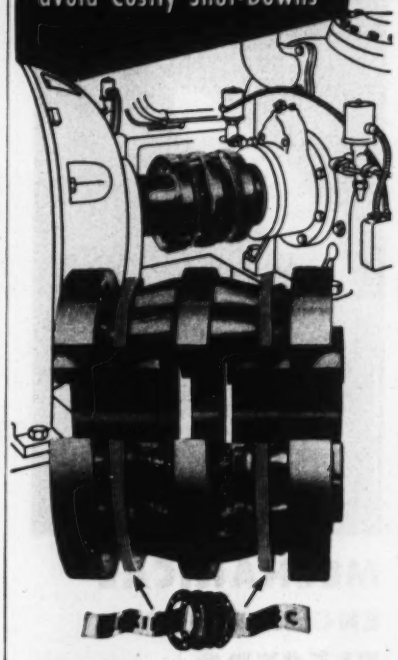
## Steam Generators, Heat Recovery and Process Equipment

A 20-page condensed catalog, being circulated by Union Iron Works, covers their line of Union steam generators and allied equipment.

Described are eight basic arrangements of two-, three-, and four-drum steam generators furnished to meet a range of loads, pressures, and temperatures for power, process, and space heating; heat recovery units, including fire-tube and water-tube boilers, plain-tube and cast iron extended-surface economizers; and Union process equipment, including Dowtherm vaporizers, reaction kettles, autoclaves, heat exchangers, and liquid heaters.

Design drawings and photos are accompanied by summaries of salient features. Copies of Bulletin G. B.-153 are available, without charge, by writing the Union Iron Works, Erie, Pa.

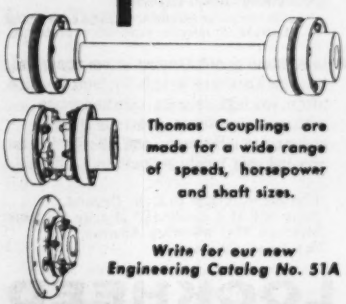

Specify THOMAS ALL METAL FLEXIBLE COUPLINGS for Power Transmission to avoid Costly Shut-Downs



**Patented Flexible Disc Rings of special steel transmit the power and provide for parallel and angular misalignment as well as free end float.**

DISTINCTIVE ADVANTAGES

| FACTS | EXPLANATION |
|---|---|
| NO MAINTENANCE | Requires No Attention. Visual Inspection While Operating. |
| NO LUBRICATION | No Wearing Parts. Freedom from Shut-downs. |
| NO BACKLASH | No Loose Parts. All Parts Solidly Bolted. |
| CAN NOT "CREATE" THRUST | Free End Float under Load and Misalignment. No Rubbing Action to cause Axial Movement. |
| PERMANENT TORSIONAL CHARACTERISTICS | Drives Like a Solid Coupling. Elastic Constant Does Not Change. Original Balance is Maintained. |



Thomas Couplings are made for a wide range of speeds, horsepower and shaft sizes.

*Write for our new Engineering Catalog No. 51A*

**THOMAS FLEXIBLE COUPLING CO.**
**WARREN, PENNSYLVANIA, U.S.A.**

# KEEP INFORMED

NEW EQUIPMENT | BUSINESS NOTES | LATEST CATALOGS

## New Rolling Mill Catalog

A new 36-page bulletin which describes and illustrates Farrel rolling mills, gear drives, pinion stands and rolling mill handling equipment is now available on request. Included in the booklet are pictures of more than thirty sizes and types of mills for nonferrous rod, strip or sheet, metal foil and cold strip steel, plus illustrations of related equipment, all informatively captioned. Write Farrel-Birmingham Co., Inc., Ansonia, Conn.

## Aluminum Brazing Methods

A demonstration and explanation of the latest light-metal brazing techniques is offered to industry by Aluminum Co. of America in a new color movie.

The basic aluminum brazing methods, each of which is explained separately in the film, are: torch brazing with a gas torch; furnace brazing where the furnace supplied the heat source; and dip brazing where the assemblies to be joined are dipped into a hot salt bath furnace filled with molten flux.

"New Horizons in Aluminum Brazing" can be borrowed for group showings. Requests for prints should be made on business letterhead to Motion Picture Section, 854 Alcoa Bldg., Pittsburgh 19, Pa.

## New Bulletin on Blow-Off Valves

A new 20-page catalog on Blow-Off Valves for boiler pressures up to 400 lb WSP has just been issued by the Yarnall-Waring Co.

The catalog, designated as Yarway Bulletin B-426, contains full details of Yarway Seatless Blow-Off Valves and Yarway Double-Tightening Blow-Off Valves.

Copies of the catalog may be had by writing Yarnall-Waring Co., 108 Mermaid Lane, Philadelphia 18, Pa.

## Proximity Meter-Capacitance Gauge

A two-page bulletin describing a new and extremely versatile measuring instrument, the Fielden Proximity Meter-Capacitance Gauge, has been prepared by Fielden Instrument Div., Robertshaw Fulton Controls Co. This compact electronic device compares, measures, or monitors dimensions and distortions which were previously impossible to obtain by mechanical means.

The Fielden Proximity Meter-Capacitance Gauge is applicable to both static and dynamic measurements and is sensitive to 0.05 micro-microfarad or closer. Free copies are available from Fielden Instrument Div. at 2920 N. Fourth St., Philadelphia 33, Pa.

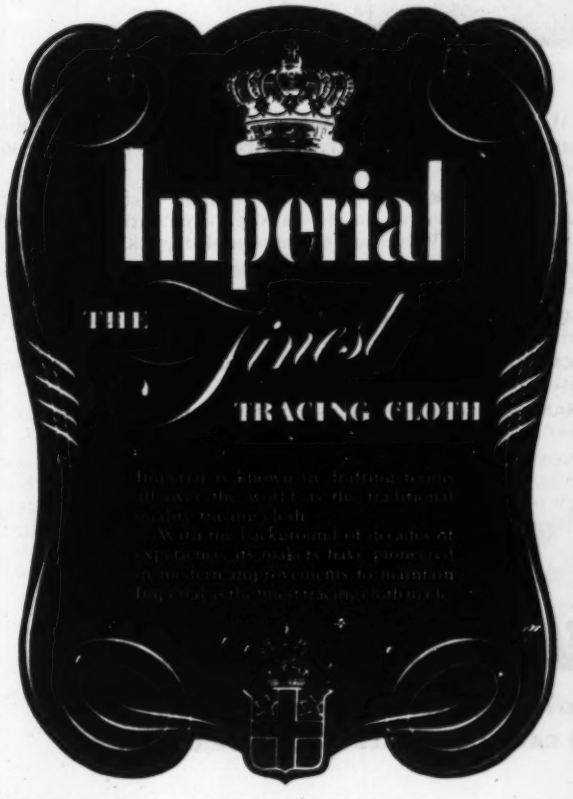
## Wire Forms

Dudek & Bock Spring Mfg. Co., 2100 W. Fulton St., Chicago 12, Ill., has published an educational brochure, which presents in easily understandable language the story on the nature and uses of wire forms. Shows how wire forms can do the work of complicated parts, effecting saving. This brochure makes ordering much easier, translates technical data into simple language. Also includes information chart on coil spring manufacturing variations. Sent on request.

## Testing Machine for Ball Bearings

Micrometrical Mfg. Co. has announced a four-page illustrated bulletin on the Anderometer, a shop instrument for testing assembled ball bearings in production or receiving inspection. This bulletin discusses the noise and vibration produced by a ball bearing, and tells how the Anderometer gives a numerical rating of the combined waviness of the balls and raceways as a measurement of bearing quality, and describes the unit of measurements, called the anderon.

Copies of the bulletin are available on request from Micrometrical Mfg. Co., 345 S. Main St., Ann Arbor, Mich.

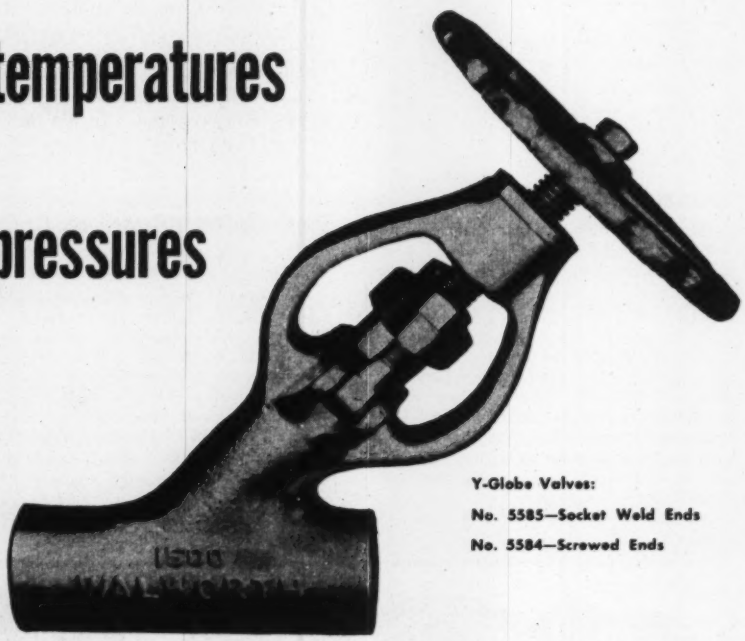



For precision-made seals
use LINEAR "O" RINGS
Available from Linear is a wide variety of high quality, precision moulded "O" rings for industrial applications ... also "O" rings to meet the latest government requirements, such as AN or MS types to MIL P-5516, MIL G-5510, MIL P-5315 requirements.
Write or call for complete information.
"PERFECTLY-ENGINEERED PACKINGS"
LINEAR
LINEAR Inc., State Rd. & Levick St., Philadelphia 35, Pa.

# Walworth's NEW small cast steel valves

## SERIES 1500 – SIZES ¼ to 2 inches

handle HIGH temperatures HIGH pressures



Y-Globe Valves:
No. 5585—Socket Weld Ends
No. 5584—Screwed Ends

Walworth is proud to make these new Small Cast Steel Valves available to power stations . . . oil refineries . . . ships . . . wherever piping is subject to severe pressures and temperatures. Non-shock service ratings of these valves: 1500 psi–950F for steam; 3600 psi–100F for water, oil or gas. Cast of chromium molybdenum steel, they are compact and light, yet exceptionally strong. Both Y-Globe and Angle type valves are available.

Angle Valves:
No. 5587—Socket Weld End
No. 5586—Screwed End

Simplified Walworth design eliminates many of the valve problems encountered in high pressure service. Among the features of this new valve are:

**INTEGRAL BODY AND YOKE** – made from a single casting without threading or welding. Bonnet joint — always a potential source of leakage — is eliminated. Valves can be reassembled quickly and easily.

**ROTATING DISC** – prevents valve seat distortion and consequent leakage. Cuts down replacements.

**WELDED SEAT RING** – compensates for changes in pressure and temperature—eliminates a major source of leakage.

**SPECIAL BACK SEAT BUSHING** – permits repacking the valve under pressure with greater safety.

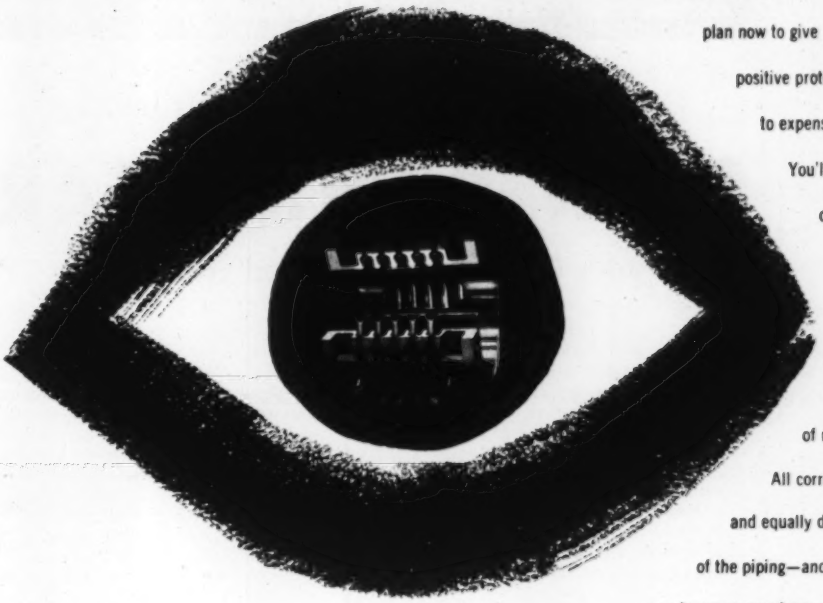
**PACKING CHAMBER** – designed to dissipate heat thus keeping packing rings at lower temperatures—gives them longer life.

These valves are available with either socket weld ends or screwed ends, in sizes ranging from ¼ to 2 inches. For further information on Walworth series 1500 Small Cast Steel Valves, see your local Walworth distributor, or write for Circular No. 134.

# WALWORTH

**valves • fittings • pipe wrenches**

**80 EAST 42nd STREET NEW YORK 17, N. Y.**



If you've got your eye
on a profitable future,
plan now to give
positive protection
to expensive piping and equipment.
You'll avoid costly failure
due to expansion or contraction
by specifying Zallea
Duo-Equalizing Expansion Joints.
These joints are designed
to eliminate unequal distribution
of movement among the corrugations.
All corrugations move simultaneously
and equally during expansion or contraction
of the piping—and no corrugation
can be compressed or extended
more than the proportional amount
for which it is designed.

Zallea already has, or will make, expansion joints for every service. For information on standard types, request Bulletin 351. For consultation on special problems, ask us to have our representative call.

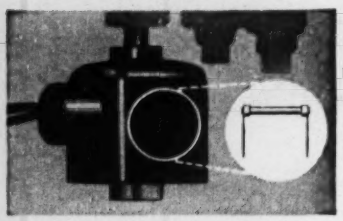
*Zallea* *expansion joints*

ZALLEA BROTHERS, 820 LOCUST STREET, WILMINGTON 99, DELAWARE

*World's Largest Manufacturers of Expansion Joints*

# News About Created-Metals

## Thermistors Provide Vital Time Delay

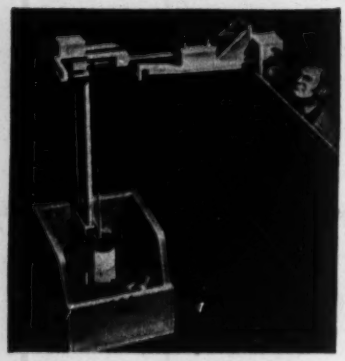


Smoky starts, puff-back and flutter in oil burners were checked by using a Carboloy Thermistor in the burner's electrical control.

The Thermistor delays the opening of a solenoid valve until the combustion chamber is ready to receive properly aerated oil. A mechanical timer is eliminated, and the cost of the unit reduced.

Thermistors are the most thermally sensitive resistor material known. Their resistance – unlike metals – changes negatively with temperature increases. They are ideal for temperature compensation, temperature detection, warning devices and controls. For more information, write: Carboloy Department of General Electric Company, 11133 E. 8 Mile Road, Detroit 32 Michigan.

## Hevimet Containers Stop "Hot Atoms"



Containers made of Carboloy Hevimet are making the job of handling and transporting radioactive materials easier and safer.

Because Hevimet is almost 50% heavier than lead, and provides 40% more gamma ray protection, these containers are smaller, less bulky . . . yet safer than lead.

Hevimet is an ideal material for all radioactive shielding. It is readily machinable, dimensionally stable and of high tensile strength For more information, write: Carboloy Department of General Electric Company, 11133 E. 8 Mile Road, Detroit 32, Michigan.

### Give your customer more for his money

# SLOW DOWN WEAR

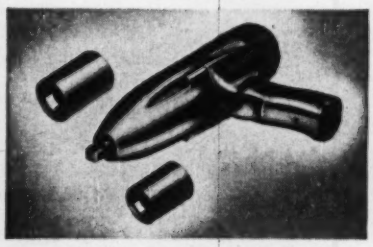
### with Carboloy® cemented carbides

Wear is the common denominator of all equipment, reducing life, accuracy and greatly increasing costs.

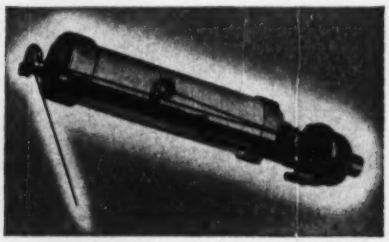
To slow down wear, many product and machine designers are applying Carboloy cemented carbides. In most instances, wherever friction, corrosion, erosion or abrasion are met, Carboloy cemented carbides can increase durability *many times over.*

These three case histories are typical of many more which may suggest important wearproofing possibilities for your own machines and products.

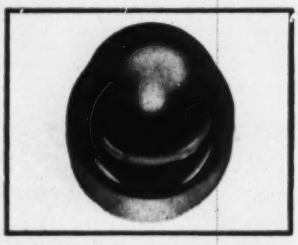
Look over *your* products and call upon the Carboloy Engineering Appraisal Service for expert assistance. We will work with you in selecting and applying the cemented carbide that will best solve *your* wear problem. This service is free. Please write.



Power socket wrenches, equipped with carbide inserts, outlasted ordinary wrenches a minimum of 15 to 20 times; eliminated screw, product damage caused by wrench slippage; sharply cut socket replacement costs and production line downtime.



In textile mills, threads traveling at high speeds quickly cut through steel or porcelain guides. Carbide guide ring inserts, used to resist such wear, lasted 50 to 100 times longer. They also greatly reduced thread snagging and snapping, spoilage and downtime.



Subsurface pumps in oil wells use balls and seats of Carboloy cemented carbide to resist acids and abrasive sands found in crude oil. Carboloy balls and seats outlast steel 20 times; maintain sphericity under severest conditions of impact and pressures.

**Put These Outstanding Characteristics To Work In Your Plant:**

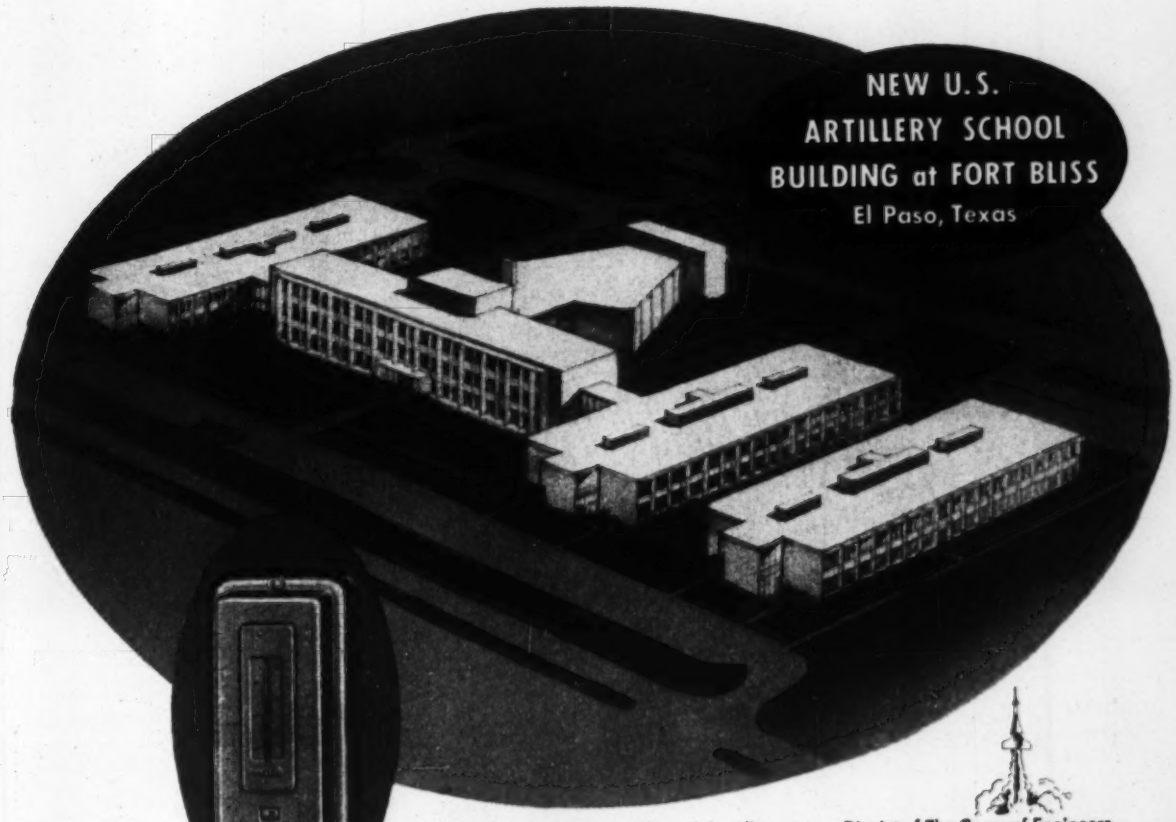
- High abrasion resistance
- High corrosion resistance
- High erosion resistance
- High heat resistance
- High impact strength
- Non-magnetic
- Light weight (where desired)

**CARBOLOY**

**DEPARTMENT OF GENERAL ELECTRIC COMPANY**

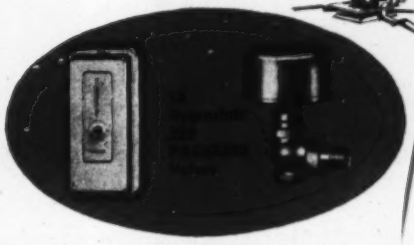
**11133 E. 8 Mile Road, Detroit 32, Michigan**

"Carboloy" is the trademark for products of the Carboloy Department of General Electric Company

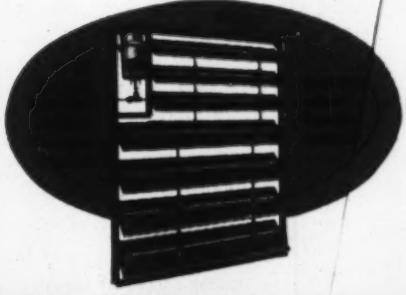

NEW U.S.
ARTILLERY SCHOOL
BUILDING at FORT BLISS
El Paso, Texas

Designed under the supervision of the Albuquerque District of The Corps of Engineers by Carroll & Daeuble and Landauer, Guerrero & Shafer, Architects-Engineers
General Contractors: Robert E. McKee, Inc., El Paso, Texas.
Mechanical Contractors: J. S. Brown — E. F. Olds Plumbing & Heating Co.

**214 Powers Room Thermostats**
Used here.



Powers **PACKLESS** Control Valves eliminate packing maintenance, leakage of water, steam or loss of vacuum



# POWERS

**Pneumatic System of TEMPERATURE and HUMIDITY Control**

**Selected for ANTI-AIRCRAFT and GUIDED MISSILES Branch of the Artillery School**

TAXPAYERS will derive a big return from their investment in this huge academic building. From it will come increased strength for our defenses to h[illegible] back and defeat aggression.

Proper temperature for maximum com[illegible] efficiency will be maintained in all class[illegible] torium and administrative facilit[illegible] control system.

With over 60 years of experien[illegible] line of controls for heating [illegible] industrial processes—PO[illegible] help with your temp[illegible] problems.

POWERS CONNERS

Established in 1891 • THE POWERS REGULATO[illegible]

# *Keeping pace with industry for 100 years*

This early "Roots" catalog, published in 1879, offered only Rotary Positive Blowers. That was our exclusive business at that time—25 years after the invention of the rotary positive principle by Francis M. Roots.

Today, because of the greatly increased use of gas and air for industrial purposes, it takes a great many bulletins and booklets to describe our expanded line of products. As new ideas, new developments are utilized in industrial processing, Roots-Connersville keeps pace with new equipment to handle gas and air most effectively and economically. And that is still our only business.

Into these bulletins, any of which are yours for the asking, are condensed our 100 years of experience in building such equipment, from the first Rotary Positive Blower in 1854 to our latest 1953 development, the Spiraxial Compressor. They describe R-C products which are up-to-date in design and construction, to match specific needs of industry.

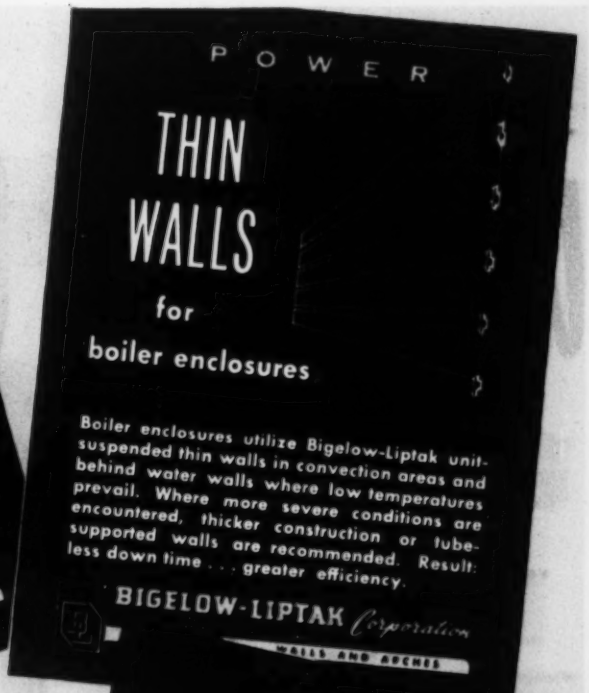
We suggest that when your business has a job of handling gas or air, you consult the exclusive specialists for 100 years.

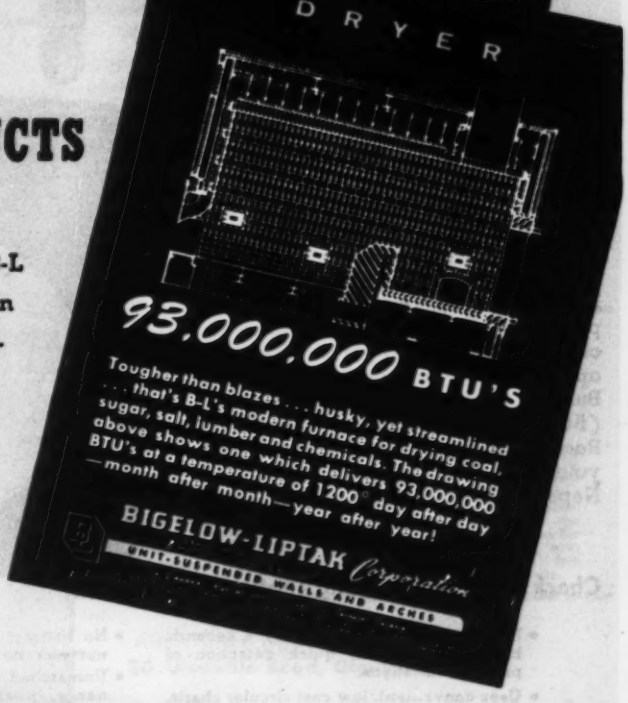
**ROOTS-CONNERSVILLE BLOWER**

A DIVISION OF DRESSER INDUSTRIES, INC.
354 Michigan Ave. • Connersville, Ind.

BLOWERS
HUMIDITY Control
Selected for ANTI-AIRCRAFT and GUIDED MISSILES
Branch of the Artillery School
TAXPAYERS will derive a big return from their
investment in this huge academic building. From it
will come increased strength for our defenses to b
back and defeat aggression. [illegible]
Proper temperature and humidity control is maintained at the
efficiency will be maintained at the
torium and administration building.
control system [illegible]
With over 60 years of experience
line of control devices—
Industrial
help with
problems.
RS REGULATO

REFINING
CASTABLE LININGS
for Regenerators
Engineering . . . materials . . . erection help! These are three ways Bigelow-Liptak can help refineries in the design of castable linings for regenerators and other petro-chemical furnaces. It all adds up to one-source efficiency —continuous on-stream service.
BIGELOW-LIPTAK Corporation
UNIT-SUSPENDED WALLS AND ARCHES


POWER
THIN WALLS
for
boiler enclosures
Boiler enclosures utilize Bigelow-Liptak unit-suspended thin walls in convection areas and behind water walls where low temperatures prevail. Where more severe conditions are encountered, thicker construction or tube-supported walls are recommended. Result: less down time . . . greater efficiency.
BIGELOW-LIPTAK Corporation
WALLS AND ARCHES


DRYER
93,000,000 BTU'S
Tougher than blazes . . . husky, yet streamlined . . . that's B-L's modern furnace for drying coal, sugar, salt, lumber and chemicals. The drawing above shows one which delivers 93,000,000 BTU's at a temperature of 1200° day after day —month after month—year after year!
BIGELOW-LIPTAK Corporation
UNIT-SUSPENDED WALLS AND ARCHES

# TYPICAL B-L PRODUCTS FOR INDUSTRY

**There are many, many applications for B-L furnace construction throughout industry. In steel mills, power houses, refineries and petro-chemical plants, sugar mills, coal mines, glass plants, city incinerators—anywhere in the heat of things—you'll find B-L installations. They're hanging up new records every day—providing top performance at a lower cost per BTU. You can get more information if you write—*today!***

**BIGELOW-LIPTAK *Corporation***

and Bigelow-Liptak Export Corporation
2550 W. GRAND BLVD. • DETROIT 8, MICHIGAN

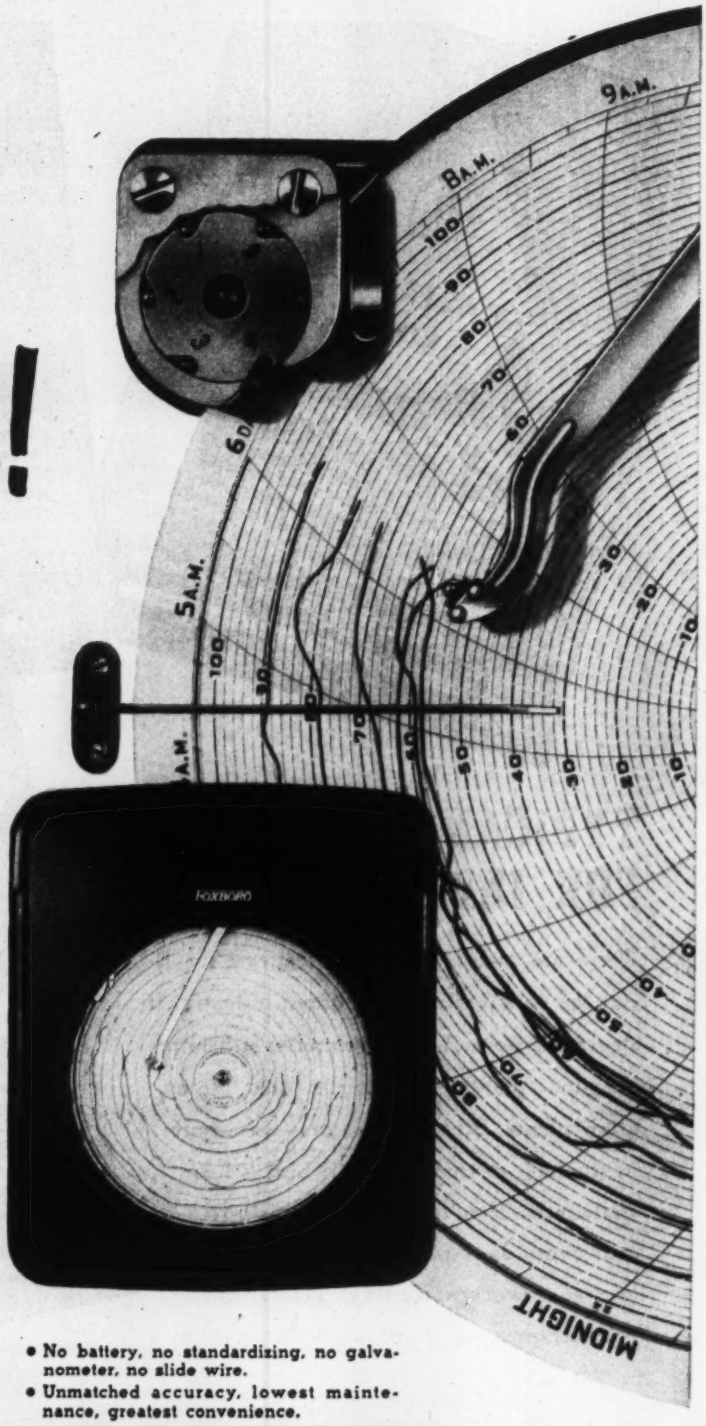
UNIT-SUSPENDED WALLS AND ARCHES

*In Canada:* Bigelow-Liptak of Canada, Ltd., *Toronto, Ontario*

ATLANTA • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND • DENVER • HOUSTON • KANSAS CITY, MO. • LOS ANGELES • MINNEAPOLIS • NEW YORK
PITTSBURGH • PORTLAND, ORE. • ST. LOUIS • ST. PAUL • SALT LAKE CITY • SAN FRANCISCO • SAULT STE. MARIE, MICH. • SEATTLE • TULSA • VANCOUVER, B.C.

# What a record!

## ...6 Color-coded Temperature Records on one ROUND Chart




### THE MULTI-RECORD *Electronic* DYNALOG*

What convenience! What economy! You can record up to 6 related temperatures on a single *circular* chart with this Foxboro Multi-Record Dynalog. Not only saves panel space, but simplifies comparison of records. There's only one pen arm — yet all 6 records appear in different, distinctive colors. Bulletin 427-1 tells the complete story. (Bulletin 444 describes the Multi-Record *Pneumatic* Receiver). Write for your copy. The Foxboro Company, 963 Neponset Ave., Foxboro, Mass., U.S.A.

*Reg. U. S. Pat. Off

***Check these outstanding features***

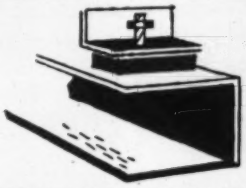
- High speed recording — only 6 seconds between prints for quick detection of process variations.
- Uses convenient, low cost circular charts.
- Each record line has its own distinctive, non-smudging color.
- No battery, no standardizing, no galvanometer, no slide wire.
- Unmatched accuracy, lowest maintenance, greatest convenience.
- Available with alarms or on-off control.
- Thermocouple or resistance-bulb types.

**FOXBORO** REG. U. S. PAT. OFF. MULTI-RECORD DYNALOG

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

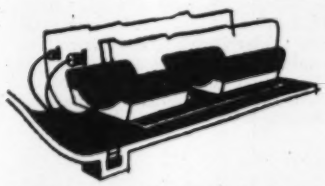
## FELT for GASKETS (1)

There has to be a seal between the lid and body of electric power transformers, to exclude dirt and moisture, hold in the oil that insulates and cools. Felt is widely used for this purpose.



## FELT absorbs VIBRATION (2)

To isolate spring-suspended gasoline tanks from the chassis of trucks and absorb road shocks and weaving strains, felt pads are used. These give enough to protect the tanks, but not enough to disturb gas lines.



## FELT for LUBRICATION (3)

Many locomotive journals are lubricated by felt, cut to fit the hub. Pumped oil is fed evenly, waste-grabbing eliminated. Length of life of the felt is estimated at 75,000 to 100,000 miles of perfect lubrication.

## FELT for POLISHING (4)

The final polishing operation on steel cutlery changes the finish from dull to bright. About .002" of steel is removed by felt polishing discs, fed with fine pumice. The discs are slotted for flexibility.

## FELT in REFRIGERATION (5)

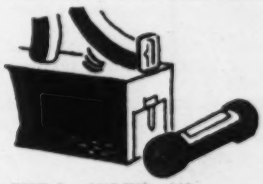
In refrigerators and air conditioners there is usually a cartridge filled with a dehydrating agent. Felt is used as a filter to prevent small particles of the drying crystals being carried into the refrigerant line.

## FELT CLUTCH FACING (6)

Industrial sewing machines have a clutch, which must take hold quickly, yet smoothly and firmly. These clutches operate properly when faced with felt discs cut to size and shape. This is a frictional application of felt.

## FELT for HONING (7)

The cylinders of internal combustion engines are finished by honing. The honing head carries abrasive stones alternated with strips of felt, the latter greatly improving the quality of the surface obtained.



## FELT for SHOCKS (8)

Pneumatic carriers of both large and small sizes are in wide use. American supplies special felts for them. One type is used as a bumper head on the carrier to absorb shock on delivery; another is an air-pressure seal.

## FELT for FIRE EXTINGUISHERS (9)

Hand-pumped fire extinguishers use felt washers for lubrication, for holding compression, as a bumper for the upstroke, and as a cushion for the nozzle. American also supplies flame-proofed felt for airplanes, theatres, etc.

GET THE FACTS ABOUT

# FELT

AND WHAT IT CAN DO FOR YOU

These are just a few of the many applications of felt in plants and products. Remember that felt is an engineering material, which can be specified as closely as any other. American makes felts as soft as a kitten's ear, as hard as a board, and many other types as well, including oilless bearings, laminations of synthetic rubber and felt. We also cut felt parts in many shapes, designs and sizes to your blueprints. Our Engineering and Research laboratory will gladly collaborate with you on the selection of the correct felt for maximum economy and satisfaction. Mail the coupon below for further information.

AMERICAN FELT COMPANY

## 50 Glenville Road, Glenville, Conn.

1 2 3 4 5 6 7 8 9

Please send me further information about the application circled above.

NAME.....

TITLE.....

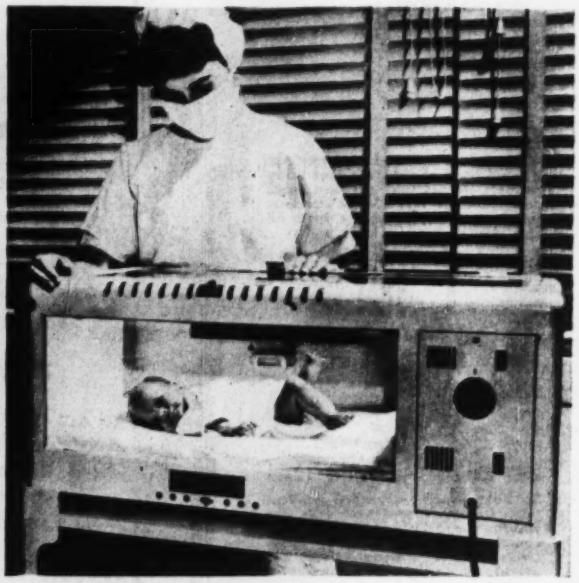
FIRM.....

STREET.....

CITY.....ZONE.....STATE.....

# How would YOU solve these two problems?

**1. MEN AND WOMEN BOTH** like nylon fabrics. Important key to producing successful nylon fabrics is the heat-setting process. Temperature-control must be accurate, and reliable yet readily adjustable. "National" Nylon Heat Setting Machines used by the leading textile mills employ THERMOSWITCH® units in the heated rollers . . . get highest efficiency . . . greatest safety . . . most economical fuel consumption.



**2. BABY INCUBATOR MUST BE SAFE.** Engineers who design Armstrong Baby Incubators say "Safety is a *must* where babies are concerned. That is why all our baby incubators are tested and approved by Underwriters Laboratories. That is why we use only Fenwal THERMOSWITCH units to control all-important temperature and humidity. Inspection reports on more than 22,000 THERMOSWITCH units show a remarkable picture of consistent reliability."

**3. THIS IS IT** — the Fenwal THERMOSWITCH control is simple — compact shell contracts or expands *instantly* with temperature changes, opening or closing electrical contacts. Adjustable and highly resistant to shock and vibration. Fenwal THERMOSWITCH units are solving temperature problems and helping to improve the final product throughout all industry.

**4. SEND FOR THIS BROCHURE** for complete explanation of the unique THERMOSWITCH unit. Also ask for more detailed, illustrated discussions of the problems above. Fenwal engineers will be glad to help you solve your temperature control problems involving heat, humidity, radiant heat, pressure and other variables. Write Fenwal Incorporated, 53 Pleasant St., Ashland, Massachusetts.

Fenwal

**THERMOSWITCH®**

**Electric Temperature Control and Detection Devices**

***SENSITIVE . . . but only to heat***

# *Why* you can *lower inspection costs*

## with a Kodak Conju-Gage Gear Checker

### *Why* the composite check

The composite check recommended in American Standard B6.11-1951 tests gears functionally by running the gear against a master of known accuracy. The resulting displacement shows at once the cumulative effect of as many as six types of error—eliminates time-consuming checks for each individual error. The check is rapid and conclusive.

### *Why* the Kodak Conju-Gage Gear Checker

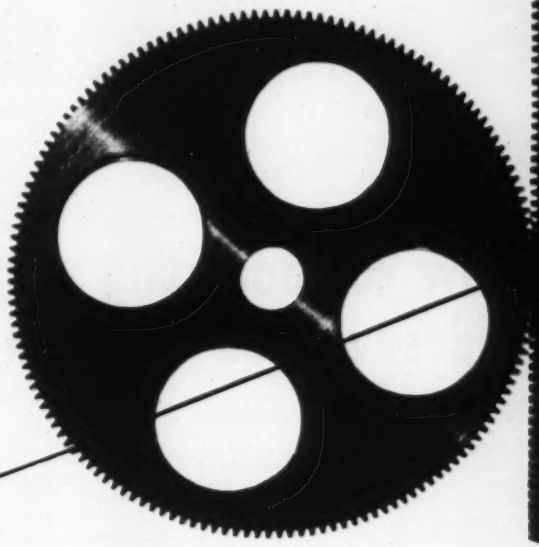
To meet today's tolerance requirements, the Kodak Conju-Gage Gear Checker uses a master made with a new order of precision. This is the Kodak Conju-Gage Worm Section, produced by thread grinding under control of a precision lead screw.

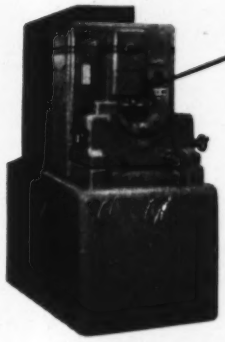
The accuracy inherent in this method means every right gear is passed by the worm section, reducing rejection losses. The transverse curvature produced by this method provides a master that can be used to check any gear of like pitch and pressure angle, regardless of helix.

Not only can a single worm section be used in place of a number of circular masters, but such a worm section can be reground to specification as often as necessary—at a fraction of replacement cost. It is easily checked for accuracy by familiar toolroom procedures.

You can find out more about the economies possible through Kodak Conju-Gage Instrumentation by sending for a copy of the booklet, "Kodak Conju-Gage Gear Testing Principle." Write to:

**Special Products Sales Division**
**EASTMAN KODAK COMPANY**
**Rochester 4, N. Y.**





The Kodak Conju-Gage Gear Checker automatically records the composite effects of runout, base pitch error, tooth thickness variations, profile error, lead error, and lateral runout. Illustrated is the Kodak Conju-Gage Gear Checker, Model 4U, for gears up to 4⅛" pitch diameter. Larger and smaller models are also available.

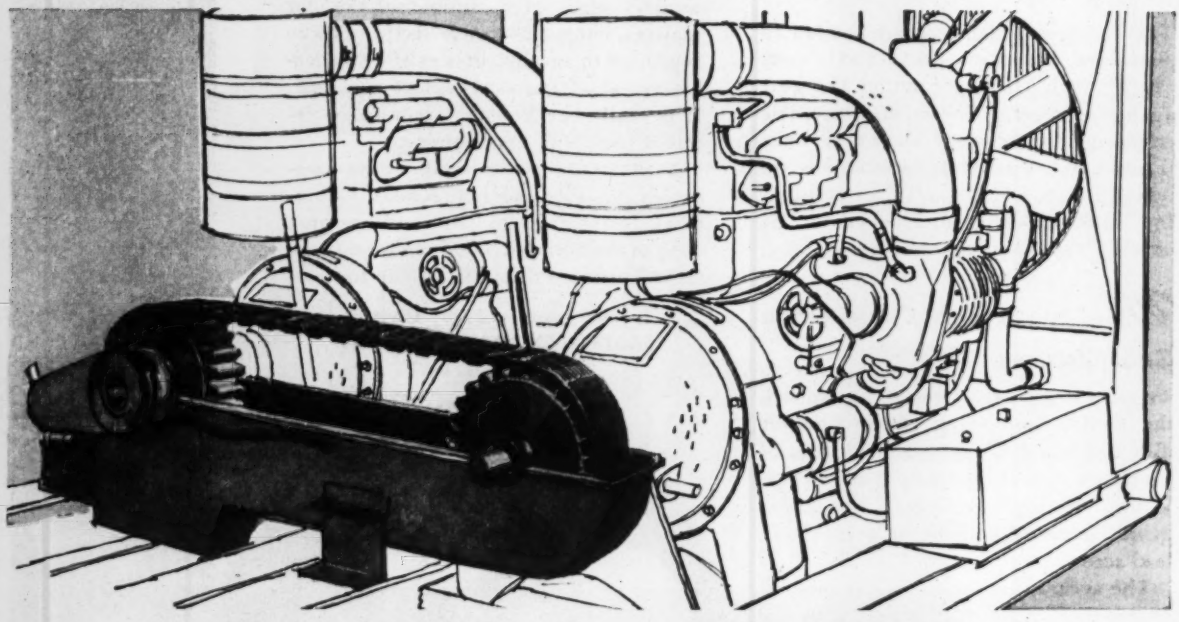
## CONJU-GAGE INSTRUMENTATION

***... a new way to check gear precision in action***

*To inspect all kinds of complex parts on a bright screen, Kodak also makes two highly versatile contour projectors.*

Kodak

# Morse HY-VO DRIVE for a new age in power transmission!



## How compounding with HY-VO could save you as much as $4,560

**Now,** gain new advantages in buying and compounding smaller, higher speed engines with Morse Hy-Vo Drive.

**You make major cost savings.**

**The total cost** of two high-speed engines and the Hy-Vo Drives with which they are compounded will usually be considerably less than a single large engine of equivalent horsepower. A brief look at some figures will show how this works . . .

**For example,** if you needed 250 continuous horsepower at 1200 rpm., you could: 1) Buy a manufacturer's 250 hp., 1200 rpm. engine, which lists for $13,380; 2) buy the 250 hp., 1800 rpm. engine for $11,930 (using Hy-Vo as a connection and reduction drive, also eliminates the costly flexible coupling normally required in choice No. 1); 3) or, use two 130 hp., 1800 rpm. engines, listing for a total of $8,820, and use Hy-Vo as your compounding drive.

With the 250 hp., 1800 rpm. engine, you save $1,450, more than enough to pay for your Hy-Vo Drive. Compounding two 130 hp., 1800 rpm. engines, you save $4,560 over base list cost of the 250 hp., 1200 rpm. engine.

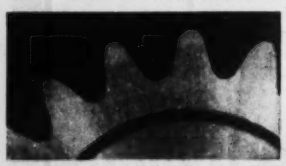
**From this saving you could pay for your Hy-Vo Drive and bank several thousand dollars.** In most cases, too, Hy-Vo will be so narrow it will eliminate costs of outboard bearings and mountings, with the bonus that single-engine operation is possible under reduced power requirement.

Other power transmission methods generally have either inherent restrictions on rotative speeds and velocities that limit 200 hp. or larger engines to 1200 rpm., or are too costly. Hy-Vo has far greater upper limits, with relatively lower cost.

Because of exceptional rotative speeds and velocities, Hy-Vo brings you comparable savings in electric motors, too. Write us for details on compounding with Morse Hy-Vo Drive.

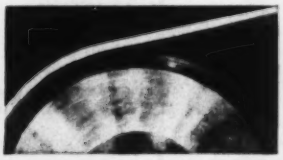
**MORSE CHAIN COMPANY**
**7601 Central Ave. • Detroit 10, Michigan**

### SOME DESIGN FACTORS BEHIND HY-VO'S SUCCESS . . .



**Hy-Vo's many design and manufacturing refinements result in a drive with unusual power transmitting capacity. Note involute tooth design of Hy-Vo Sprockets . . .**

**. . . and the new, Hy-Vo Compensating Rolling Joint, which always shifts the pitch line automatically as the Hy-Vo Chain engages the involute teeth of the sprocket.**



**Chain follows a path truly tangent to sprocket pitch circle, virtually eliminating chordal action. A new, balanced link design greatly improves stress distribution.**

MORSE
MECHANICAL POWER TRANSMISSION PRODUCTS

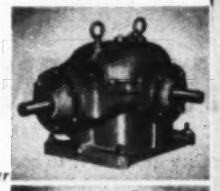
# Are YOU getting the "KNOW-HOW" ANSWERS to YOUR GEARING PROBLEMS?

Seattle Post-Intelligencer

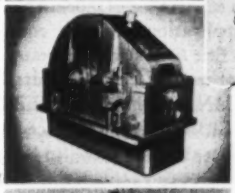
**... to hear the grease monkeys in the pits talk, the winner of the Gold Cup will be the boat with the best gear-box, a tiny mysterious gimmick which gives the hydros a lot of extra horses...**

*by Royal Brougham*

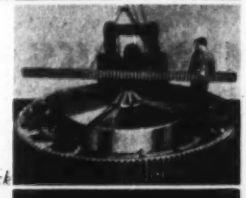
## ...and WIN IT DID!



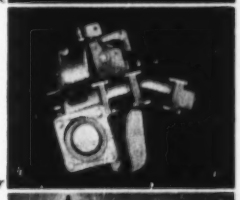
*Right-angle speed reducer*



*High-speed unit*



*Large gear and rack*



*Cone-gear aircraft actuator*

*Torq-Master*

The same engineering skill and manufacturing ability that resulted in the sensational Gear Box that enabled the Slo-Mo boats to win the Gold Cup races the past four years is ready to help you with your mechanical power transmission problems.

Many informative brochures are available. Why not let us help you with *your* mechanical power transmission problem?

***Please write, wire or phone your nearest Western Gear Works plant or office.***

5340

**WESTERN GEAR WORKS**

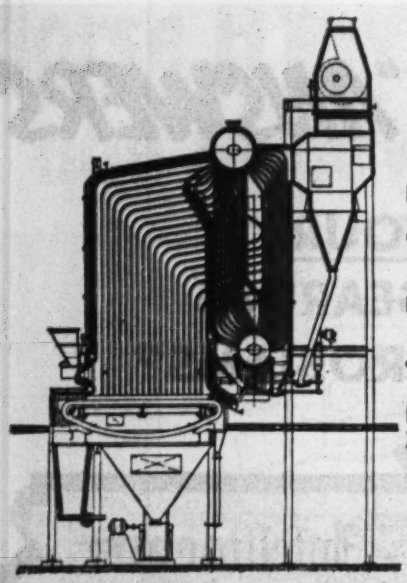
Manufacturers of **PACIFIC-WESTERN** Gear Products

**Pacific Gear & Tool Works**

Plants: Seattle, San Francisco, Belmont (S. F. Peninsula), Lynwood (Los Angeles County), Pasadena, Houston

***Plants*** — 417 Ninth Ave. S., Seattle 4, Washington
2600 E. Imperial Highway, Lynwood (Los Angeles County), California
1035 Folsom St., San Francisco 3, California
Belmont (San Francisco Peninsula), California
132-134 W. Colorado St., Pasadena 1, California
117 N. Palmer St., Houston 3, Texas

***Representatives*** — N. 2605 Division St., Spokane, Washington
930 S. E. Oak St., Portland 14, Oregon
Room 212, Ross Bldg., Denver 2, Colorado
500 South Ervay Street, Dallas, Texas
Engineering & Machinery Ltd., 1366 W. Broadway, Vancouver, B. C.



**MUNITIONS**

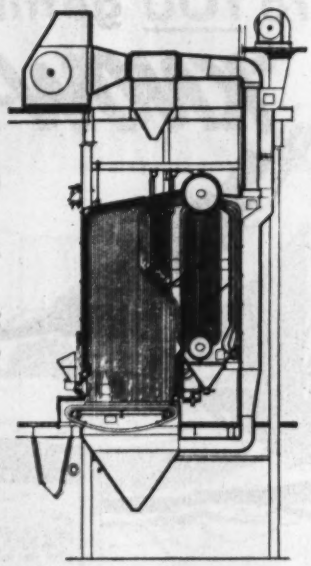
**No. Boilers . . (2)**

**Capacity each**
50,000 lbs./hr.

**Design Pressure**
160 psig

**T. T. Steam** 366 F

**Firing**
Erie City "Travagrate"



**AUTOMOTIVE**

**No. Boilers . . (2)**

**Capacity each**
100,000 lbs./hr.

**Design Pressure**
700 psig

**T. T. Steam** 750 F

**Firing**
Erie City "Travagrate"

# ERIE CITY'S 2-DRUM STEAM GENERATORS

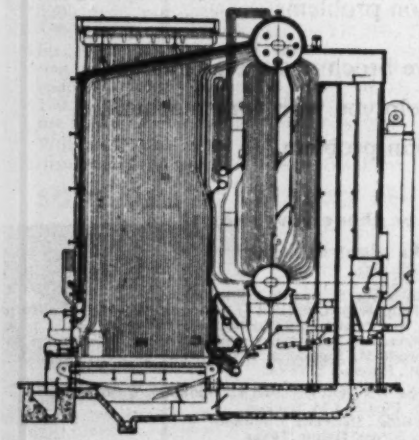
Erie City . . . pioneer in the development of the 2-drum boiler and the application of water walls to furnace design . . . offers a complete, modern line of two, three, or four drum steam generators to solve your most complex problem.

Installations such as shown here indicate the versatility of the Erie City 2-Drum steam generator. The wide range of sizes, adapted to all types of mechanical firing prove its adaptability to all classes of industry. The broad experience of Erie City qualifies it to combine proper boiler selection with efficient use of modern heat recovery equipment and proper application of firing equipment. Add to this the fact that Erie City steam generators are designed to include the best of modern utility standards and then you know . . . "YOU CAN DEPEND ON ERIE CITY FOR SOUND ENGINEERING" . . . is not just a statement. It is a positive fact that can prove to be of value and profit to you.

ERIE CITY
114 Years in Steam Generation

**ERIE CITY IRON WORKS** • *Erie, Pa.*

STEAM GENERATORS • SUPERHEATERS • ECONOMIZERS • AIR PREHEATERS
UNDERFEED AND SPREADER STOKERS • PULVERIZERS



**SUGAR**

**No. of Boilers . (2)**

**Capacity each**
150,000 lbs./hr.

**Design Pressure**
450 psig

**T. T. Steam** 570 F

**Firing** Traveling Grate

**CHEMICAL**

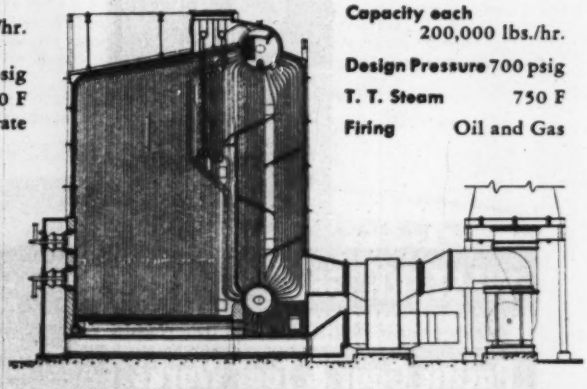
**No. of Boilers . . (3)**

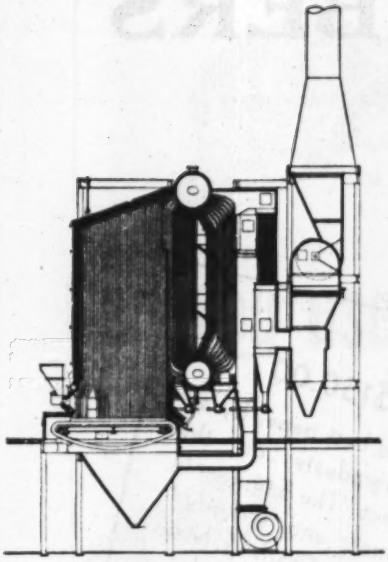
**Capacity each**
200,000 lbs./hr.

**Design Pressure** 700 psig

**T. T. Steam** 750 F

**Firing** Oil and Gas





**U. S. GOVERNMENT**

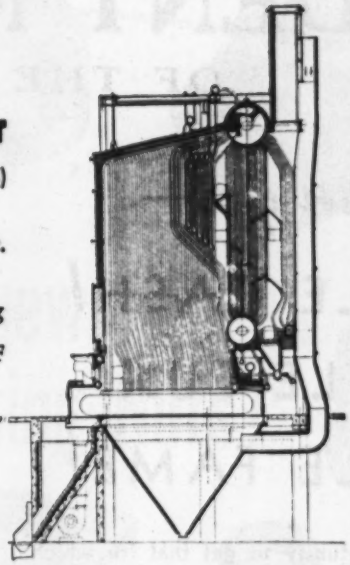
**No. of Boilers . (3)**

**Capacity each**
105,000 lbs./hr.

**Design Pressure**
200 psig

**T. T. Steam** 371 F

**Firing**
Erie City "Travagrate"



**AVIATION**

**No. of Boilers . (8)**

**Capacity each**
135,000 lbs./hr.

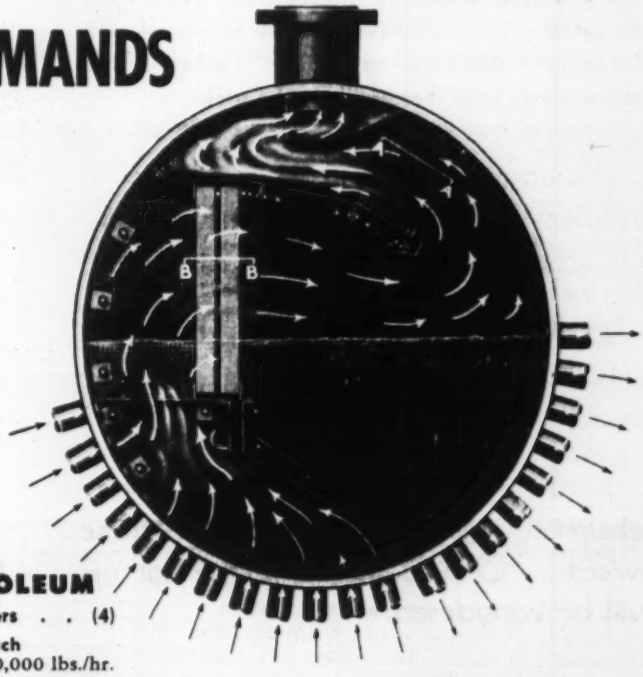
**Design Pressure**
475 psig

**T. T. Steam** 715 F

**Firing** Chain Grate

# SATISFY BROAD DEMANDS

**All Erie City** 2-drum steam generators are equipped with contact type steam scrubbers. These scrubbers utilize reverse flow and contact with bare corrugated metal surfaces to insure moisture free steam at outlet.




**PETROLEUM**

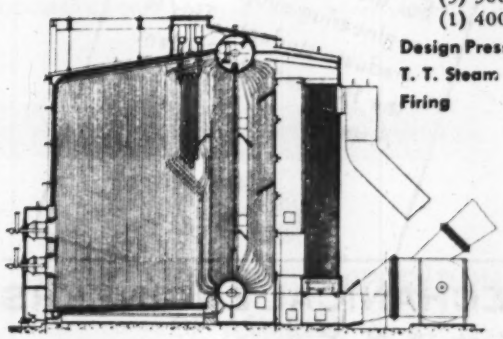
**No. of Boilers . . (4)**

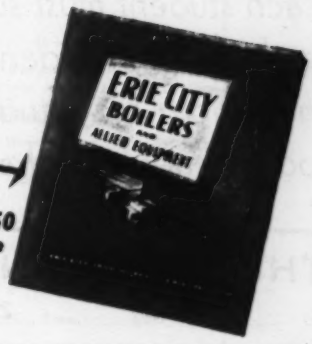
**Capacity each**
(3) 300,000 lbs./hr.
(1) 400,000 lbs./hr.

**Design Pressure** 725 psig

**T. T. Steam** 688 F

**Firing** Oil and Gas



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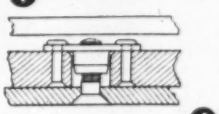
**1 TWO-LUG INVERTED ANCHOR NUT** For use where clearance or other considerations make it necessary to mount the nut upside down. Clearance hole must be provided for the barrel. Nylon inserts.

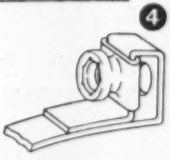
**2 LIGHT HEX NUT, KEL-F INSERT** Special KEL-F insert provides the self-locking, vibration-proof features of all ELASTIC STOP® nuts, for operation under extremely corrosive conditions—or exposed to strong acids—such as fuming nitric.

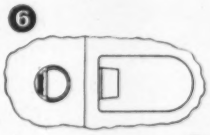
**3 TWO-LUG HIGH-TENSILE ANCHOR NUT** For use with 160,000 psi bolts, in blind mounting or in applications where ease of maintenance makes an attached nut desirable. Nylon inserts.

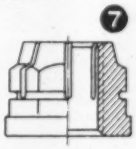
**4 SELF-LOCKING CLAMP NUT** For installation around the clamp leg, or on slotted strips where a random lengthwise positioning of the nut is necessary. Red nylon locking insert.

**5 HIGH-TEMPERATURE, CLOSE CLEARANCE DOUBLE-HEX NUT** For applications where weight, wrenching area and elevated temperatures are all major considerations. Temperatures to 1200° F.

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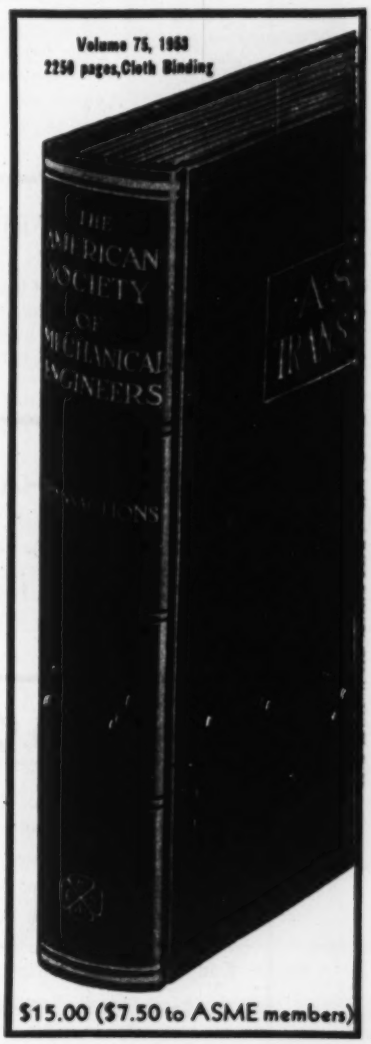
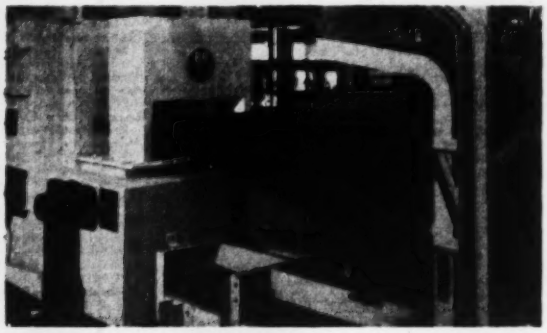


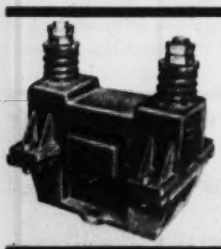
$15.00 ($7.50 to ASME members)

# Efficient, Compact, Automatic Installations Are Easier To Design With..

Feeding of steel slugs to centerless grinder is completely automatic with Syntron Parts Feeder.



Syntron Vibratory Feeder delivers continuous, controlled flow of metal parts to heat treating furnace.

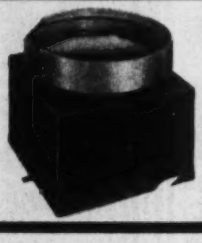


## ELECTRIC VIBRATORS

3600 controllable vibrations per minute insure a positive free flow of bulk materials through bins, hoppers and chutes. No arching or plugging. Compact—easy to install.

## VIBRATORY FEEDERS

Low cost, high tonnage handling of most bulk materials — abrasive fine or lumpy—hot or cold—dry or damp.

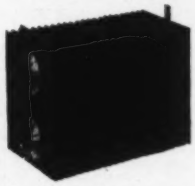


## PARTS FEEDERS

For automatic, variably controlled feeding of small parts to continuous production set-ups. Handle parts of most shapes and materials—single file—in oriented position.

## SELENIUM RECTIFIERS

Metallic—dry cell—no moving parts—high current capacity. In sizes for almost every application requiring a-c to d-c power conversion.



## SHAFT SEALS

Mechanical, self-adjusting, self-lubricating seals for rotating shafts of pumps carrying either gases or liquids. Positive sealing action on nearly any type installation.

## INFRA-RED RADIANT HEATING PANELS

Most efficient units yet developed for industrial baking, heating and drying. They heat by direct radiation—not by reflection—no blind spots.

# SYNTRON EQUIPMENT

Developed and built for long, trouble-free operation on the toughest industrial assignments, Syntron Equipment is exceptionally efficient when incorporated into automatic or semi-automatic production systems.

Additional Syntron Equipment includes Vibrating Screens & Grizzlies, Vibratory Elevators, Batch Weigh Plants, Hopper Level Switches, Flow Control Valves, ac to dc Power Conversion Units, Electric Heating Elements and Portable Power Tools.

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498 Lexington Avenue Homer City, Penna.

News

# Here's SK's NEWEST DESIGN for Rate-of-Flow Measurement— the SAFEGUARD ROTAMETER

As an answer to industry's increasing demands for *safety* and *convenience* in rate-of-flow measurement of liquids and gases, SK has designed its newest Rotameter—the Safeguard Rotameter.

This Rotameter has specific application for measurement in the higher temperatures and pressures of modern process technology, or where dangerous or valuable liquids and gases are being used.

**FOR SAFETY:**

The completely enclosed steel meter case has detachable safety glass windows, protects the metering tube from external shock, and also protects the operator if accidental tube breakage occurs.

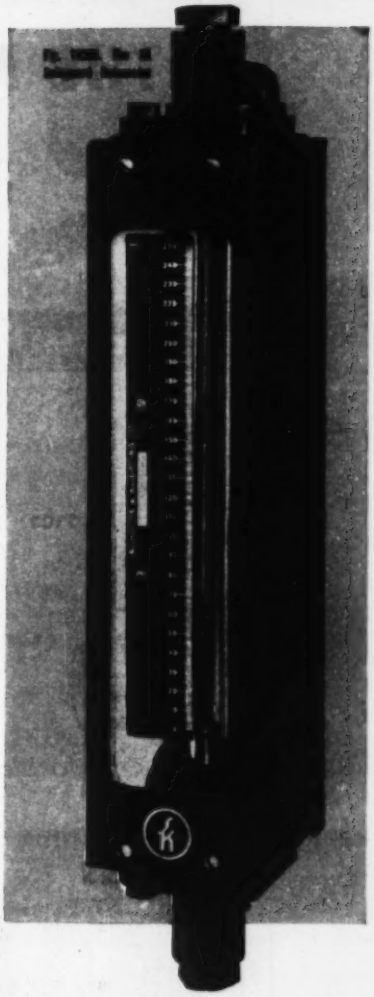
**FOR CONVENIENCE:**

*Wider* front and rear sight glass windows give maximum visibility. The detachable metal reference scale can be supplied in either units of flow or in millimeters for use with calibration charts, as desired.

Extreme construction rigidity gives precise end fitting alignment, eliminates pipe stresses on the tube.

Can be adapted for remote recording and controlling of fluid rate of flow.

Write for full information, including sizes and capacities, on this newest Rotameter design.



Glass metering tube has cylindrical inlet and outlet pieces of the same outside diameter — allowing use of the same size packing rings on either end of the tube.

Horizontal inlet and outlet can be connected in four different positions.

Two types of metal mandrel made tubes are available—the "HCF," a High Capacity Fluted tube, or the "R," a conical tapered tube without flutes.

Various rotor designs and materials permit wide capacity range within one meter.

End fittings are available in cast iron, bronze, and stainless steel.

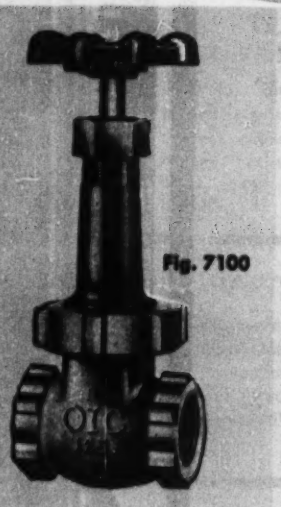
Neoprene packing gives corrosion resistance, tight seal, long service life. Other packing material is available.

Rotor removal and tube cleaning without dismantling easily done through non-leaking sealed clean-out plug.

*Manufacturing Engineers*

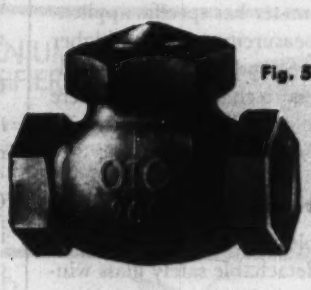
# OIC Valves

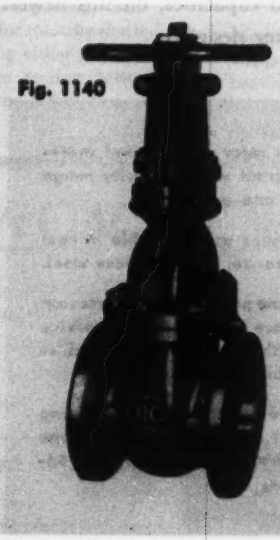
## ...THE MODERN LONG LINE



**BRONZE**

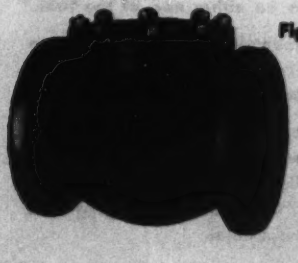
½" to 3". 125, 150, 200, 300 and 350 WSP; 300A; 200, 400, 2,000 and 2,500 WOG.






**IRON**

1¼" to 16". 125, 150 and 250 WSP; 175, 200, 400 and 500 WOG. ¼" to 4" DUO-BOLT Gates.



## CAST STEEL

2" to 16". 150, 300 and 600 lb. primary pressure series.

Fig. 6033

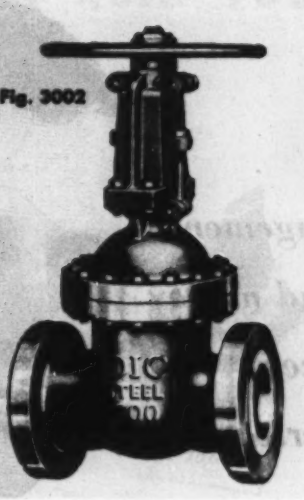


Fig. 3002

Fig. 1572

## FORGED STEEL

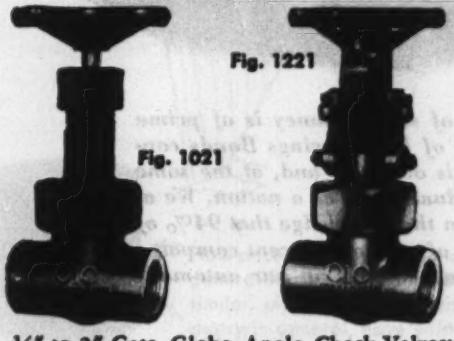


Fig. 1221

Fig. 1021

¼" to 2" Gate, Globe, Angle, Check Valves; 600 lb. primary pressure series.

## STAINLESS STEEL

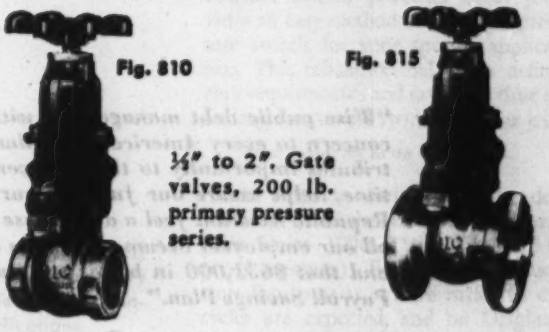


Fig. 810

Fig. 815

½" to 2". Gate valves, 200 lb. primary pressure series.

## LUBRICATED PLUG

Fig. 10

1" to 24". Iron... 175 psi to 800 psi working pressures. Cast Steel series 150 lb.-230 psi, 300 lb.-600 psi and ASA 150 lb. class.

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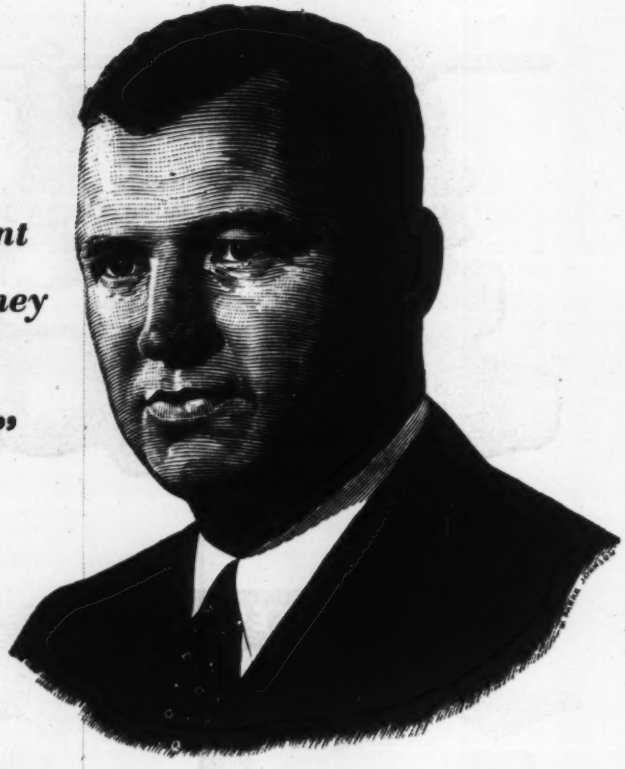
## *"Wise public debt management with its goal of sound money is of prime concern to every American."*



**MUNDY I. PEALE**
*President*
*Republic Aviation Corporation*

***"Wise public debt management with its goal of sound money is of prime concern to every American. Regular purchase of U. S. Savings Bonds contributes importantly to the achievement of this objective and, at the same time, helps assure our future security, individually and as a nation. We at Republic Aviation feel a deep sense of pride in the knowledge that 94% of all our employees became investors as a result of our most recent campaign and that $631,000 in bonds are purchased each month on our automatic Payroll Savings Plan."***

Perhaps the importance of U. S. Savings Bonds and the Payroll Savings Plan as factors in wise debt management and the achievement of sound money may not have occurred to you.

Here are a few facts and figures:

• For every dollar of public debt held by a commercial bank, about five new dollars may be created in the form of credit. Obviously, the larger the amount of the public debt held by individuals, the greater the check on inflationary tendencies.

• At the end of 1953, the cash value of Series E and H Bonds *held* by individuals was more than 36 billion dollars. This total is growing steadily, thanks largely to the month after month purchases of Series E Bonds by more than 8,000,000 Payroll Savers.

• Sales of E and H Bonds in 1953—23% higher than in 1952—provided cash for *all* E and H Bond maturities and redemptions and still left over $210,000,000 *net* for the reduction of bank-held debt.

• The ownership of more than $36,000,000,000 in Savings Bonds by millions of Americans constitutes a reservoir of future purchasing power—an asset to industry and business as well as to the individuals who built it by their Bond-conscious thrift.

Why not team up with Mr. Peale and other leaders of industry in their efforts to help America reach its goal of wise public debt management and sound money? All you have to do is (1) show a *personal* interest in your Payroll Savings Plan. Get the figures on the percentage of employee participation and the amount of monthly savings by your employees. (2) Wire, phone or write to Savings Bond Division, U. S. Treasury Department, Washington, D. C. You'll get all the help you need to build up or install a Payroll Savings Plan that will reflect your company and its interest in America.

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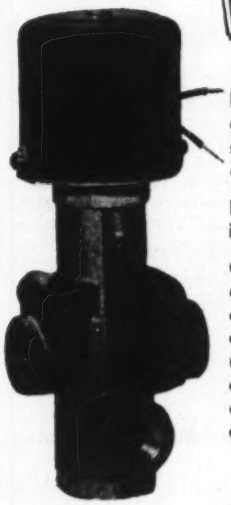
**MECHANICAL ENGINEERING**

# MAINTENANCE CAN RUIN YOU



Flow passage, functional characteristics, price and most general features of all major operating valves are very similar, pipe size for pipe size, chiefly because you, industry in general, have written the specifications.

Long operating life, free from maintenance and service, is therefore the only true basis for evaluating valve cost.

CRESCENT VALVES* have emerged as champion, time after time, wherever an accurate comparison test was conducted under actual operating conditions. Not laboratory tests, but careful comparative studies by valve users — and now Crescent customers. If you are a user of 4-way, 3-way, or shut-off Solenoid air valves, Crescent Valves will save you money; we invite comparison on your own application.

*A product of Crescent Valve Company

# BARKSDALE VALVES

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# USEFUL LITERATURE

The "Shear-Seal" principle is a revolutionary twentieth century advancement in valving extreme pressures as well as low pressures and vacuum. The only known method to achieve leakproof closure and maintain or improve sealing qualities with use. This patented principle is illustrated and discussed in a comprehensive bulletin.

Check number BV-2 on the coupon below.

New 20-page catalog includes all basic information on Barksdale Manual Shear-Seal valves, Solenoid Shear-Seal Valves, Meletron Pressure Switches, and Crescent Air Valves.

Check number 3G on coupon below.

Solenoid "Shear-Seal" Valve Catalog gives complete information on line of shut-off, diverter, 3-way and 4-way selector and 3 position selector valves for Air, Water and Oil Service to 3000 P.S.I.

Check number 1B-2 on coupon below.

Pressure Switch Selection Chart provides an easy method of finding a pressure switch for your specific application. This tabulation helps you define your requirements and saves you time in finding the correct switch for your job.

Check number M3 on the coupon below.

Piston Pressure Switch bulletin describes in detail the entire service range from 15 to 3000 P.S.I. (7000 P.S.I. proof pressure). Belongs on Production Equipment, where millions of cycles are expected, and on Original Equipment, where flexibility and price are a factor.

Check number 9612 on the coupon below.

Solenoid Air Valves, the famous Crescent 3-way and 4-way valves, are catalogued with complete technical description in this eight-page brochure. Where long service without valve maintenance or solenoid trouble is essential, these valves have become standard.

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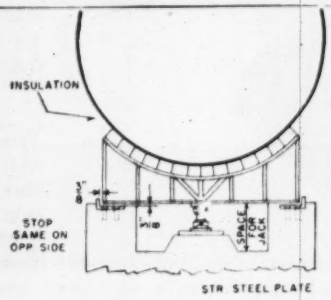
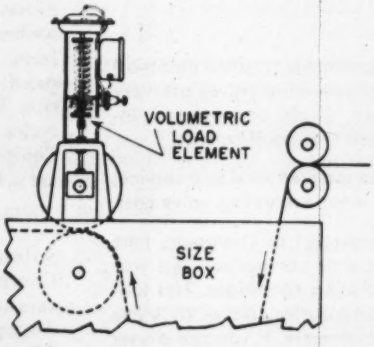
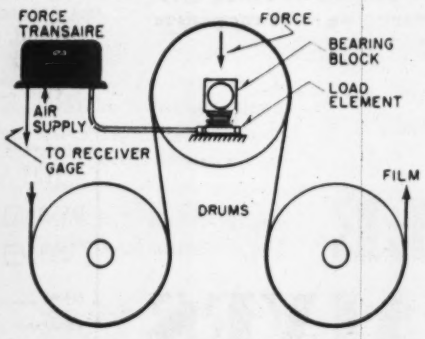
# Let us take a load off your mind!

DO YOU have a tricky load measurement problem on your mind? Something like measuring the tension on a conveyor belt for example, or the thrust on a bearing, or the weight of solids or corrosive liquids in a tank . . . ? Taylor volumetric load measuring elements have been used for years in paper mills, but there are many applications throughout the industry where these highly accurate and sensitive instruments are proving invaluable. Most recent developments afford a wide variety of ranges, greater range suppression, greater over-range protection and greater energy for positioning the pen or actuating a control mechanism. Applicable to tension and compression loads. Call your Taylor Field Engineer or write for **BULLETIN 98232.** Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.

| PROBLEM | SOLUTION | CHARACTERISTICS |
|---|---|---|
| **To accurately measure the weight of chlorine in tanks** |  | **Spool type Load Measurement Element**<br>**Range limits:** 0-240,000 lbs. for compression loads, maximum load not to exceed 400,000 lbs. Applicable to horizontal or vertical tanks, containing corrosives or solids, making conventional level measuring devices impractical. Tension loads 0-30,000 lbs. |
| **To accurately measure squeeze roll pressures on textile slashers** |  | **Diaphragm type Load Measuring Element**<br>**Range limits:** 0-5,000 lbs., maximum load not to exceed 6250 lbs. Compound ranges, tension—0—compression also available. Applicable to measure roll or nip pressures in calender stacks, press section and many other finishing operations involving processing of material between rolls. |
| **To measure film tension within very close limits as a measure of "gain" or percentage of stretch** |  | **Transaire Volumetric Load Measuring Element**<br>**Range limits:** 0-300 lbs. in range spans as short as 30 lbs. Used in conjunction with a TANSAIRE* Pressure Transmitter which sends an output air pressure to an indicating, recording or controlling receiver proportional to the force applied. Applicable to film, paper, yarn or similar tension measuring requirements. |

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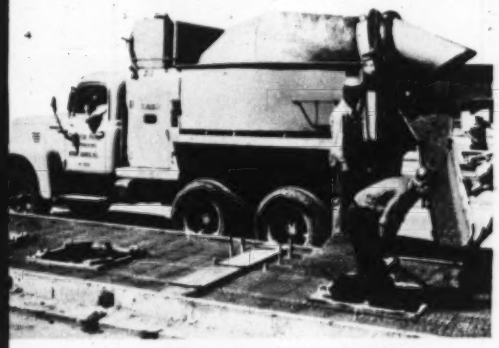
# New facts for your file on U·S·S HIGH STRENGTH STEELS

## Truck body platform frames built of USS COR-TEN steel are 20% lighter...4 to 6 times more rust resistant



By using 10-gage USS COR-TEN steel in place of 8-gage hot rolled carbon steel, Giant Manufacturing Co., Council Bluffs, Iowa, obtains maximum strength with minimum weight in the platform frames of their farm truck bodies.

This construction, which gives farmers and truckers several hundred pounds more loading capacity in these units—and thus cuts transportation cost per mile of load—has been used almost exclusively in Giant trucks since 1946.

"During this time," says the manufacturer, "we have not had a failure due to distortion or corrosion of the platform frames. Our fabrication department states that shearing and forming USS COR-TEN steel, using power equipment, is comparable to equal gages of regular carbon steel. COR-TEN steel's welding properties are excellent . . . it is easily prepared for application of enamel finish and has absolutely no tendency to flake or peel the finished coat."

Another well-known builder of farm wagons says, "We have found that the use of high strength steels is almost a must in the manufacture of farm equipment. All farm implements are subject to terrific abuse in the field and are generally without any protection whatsoever from the elements. The anti-corrosive qualities of high strength USS COR-TEN steel are naturally a major selling point in equipment of this type."

### In truck mixer parts, USS MAN-TEN steel adds strength, increases resistance to abrasion, impact and vibration

In this 4½ cu. yd. Lite-weight, Heavy Duty Hi-Boy Truck Mixer built by Blaw-Knox Company, Pittsburgh, Pa., the mixing drum, mixing blades, charging hopper and discharge chute are made of USS MAN-TEN steel. In all these parts which are subjected to the highly abrasive action of the concrete batch, MAN-TEN steel's greater resistance to abrasion plays an important part in prolonging life and keeping maintenance costs and downtime to a minimum.

MAN-TEN steel's high endurance limit, 40% greater than carbon steel, and its high yield point of 50,000 psi are additional properties that pay off in increasing the durability of this equipment.

During the past 20 years, USS High Strength Steels—USS COR-TEN, USS MAN-TEN and USS TRI-TEN—have been used in materials-handling, road-building and excavating equipment of all kinds to reduce weight, increase working capacity and to give it the stamina to stay on the job.

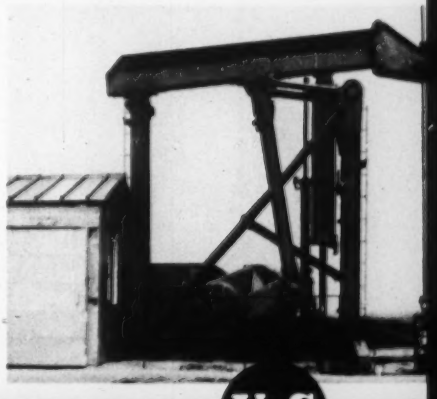
Find out how these "steels that do more" can be applied to improve your equipment—how readily they can be fabricated—and how little they cost to use. A letter to our nearest district office will bring you this information.

### USS MAN-TEN steel saves weight, ensures longer life, in air-balanced oil pumping unit

Designers of equipment for the oil industry have found in USS High Strength Steels an economical and practical solution of many of their problems. How to reduce weight? How to increase strength? How to resist corrosion? How to prolong life?

Typical is this application of USS MAN-TEN steel in the walking beam of this ultra-modern air balanced pumping unit built by the Parkersburg Rig and Reel Company, Parkersburg, W. Va.

By using USS MAN-TEN steel construction in the 24 in. walking beam in place of carbon steel, the weight of this important member has been reduced 16.6%. Yet, because USS MAN-TEN steel has a yield point of 50,000 psi—one and a half times that of carbon steel—the lighter beam is much stronger. Additional durability is ensured by the fact that MAN-TEN steel has 40% higher fatigue strength, thus providing greater resistance to vibration and reversal of stresses.



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UNITED STATES STEEL

# New facts for your file on U·S·S CARILLOY STEELS

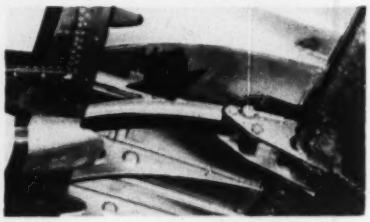
## Improved suspension system of "Patton 48" features torsion bars of Carilloy steel

• In the army's newest medium tank, the Patton 48, torsion bars made from U·S·S Carilloy steel do a better job of cushioning riding shocks and take less mounting space than suspension systems used in World War II tanks.

In rugged field tests of the Patton 48, the torsion bars constantly flex, twist, and vibrate as the tank rumbles over trenches and scales 3-foot walls. U·S·S Carilloy 8660, a high quality electric furnace steel, performs exceptionally well in this torturous service.

U·S·S Carilloy steels are solving many tough jobs like this in both military and civilian applications. And it will pay you to look for a Carilloy steel when you need maximum strength, light weight, good corrosion resistance, or any combination of these properties in heavy-duty parts that must be small in size.

## Cost cut 75% on wing flap supports with Rolled Structural T-sections of Carilloy steel



By switching from 2¼" x 3¼" alloy steel *bars* to hot-rolled T-sections of U·S·S Carilloy 4140 steel, J. C. Peacock Company and Consolidated Vultee Aircraft Corporation have reduced the cost and *improved the quality* of wing flap supports for Model 340 Convair airliners.

Flap tracks made of Carilloy T-sections not only are stronger than those formerly used, but require 4 hours less machining time and are machined with 60% less scrap loss. Finished tracks now cost only one-fourth as much as they used to.

As J. C. Peacock and Convair did, you will find exactly the alloy steel you need in U·S·S Carilloy. Carilloy steels are produced in the widest available range of analyses, sizes, forms, and heat treatments. They readily meet with the highest quality standards. If you need alloy steel of *any type* get in touch with our nearest District Sales Office.

## U·S·S Carilloy steel produced in wide variety of plate, sheet, and strip

**You can order flat-rolled *Carilloy steel* in anything from a razor blade strip to armor plate for a battleship. In U·S·S Carilloy, you get the widest selection of alloy steel plate, sheet, and strip that is obtainable from one producer. One source of supply makes purchasing easier, assures you consistent quality, and simplifies manufacturing problems.**

**Remember, too, when you buy Carilloy steels you have at your service, every day, the best metallurgical talent available. Our metallurgists have intimate knowledge of all types of alloy steels and their most economical fabrication. These men often can help you cut costs by offering practical suggestions on engineering and production.**

**For more information about Carilloy plate, sheet, and strip, and for free metallurgical assistance, get in touch with our nearest District Sales Office.**

USS

UNITED STATES STEEL CORPORATION, PITTSBURGH · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS, COAST TO COAST

UNITED STATES STEEL

New facts for your file on

# U·S·S STAINLESS STEEL

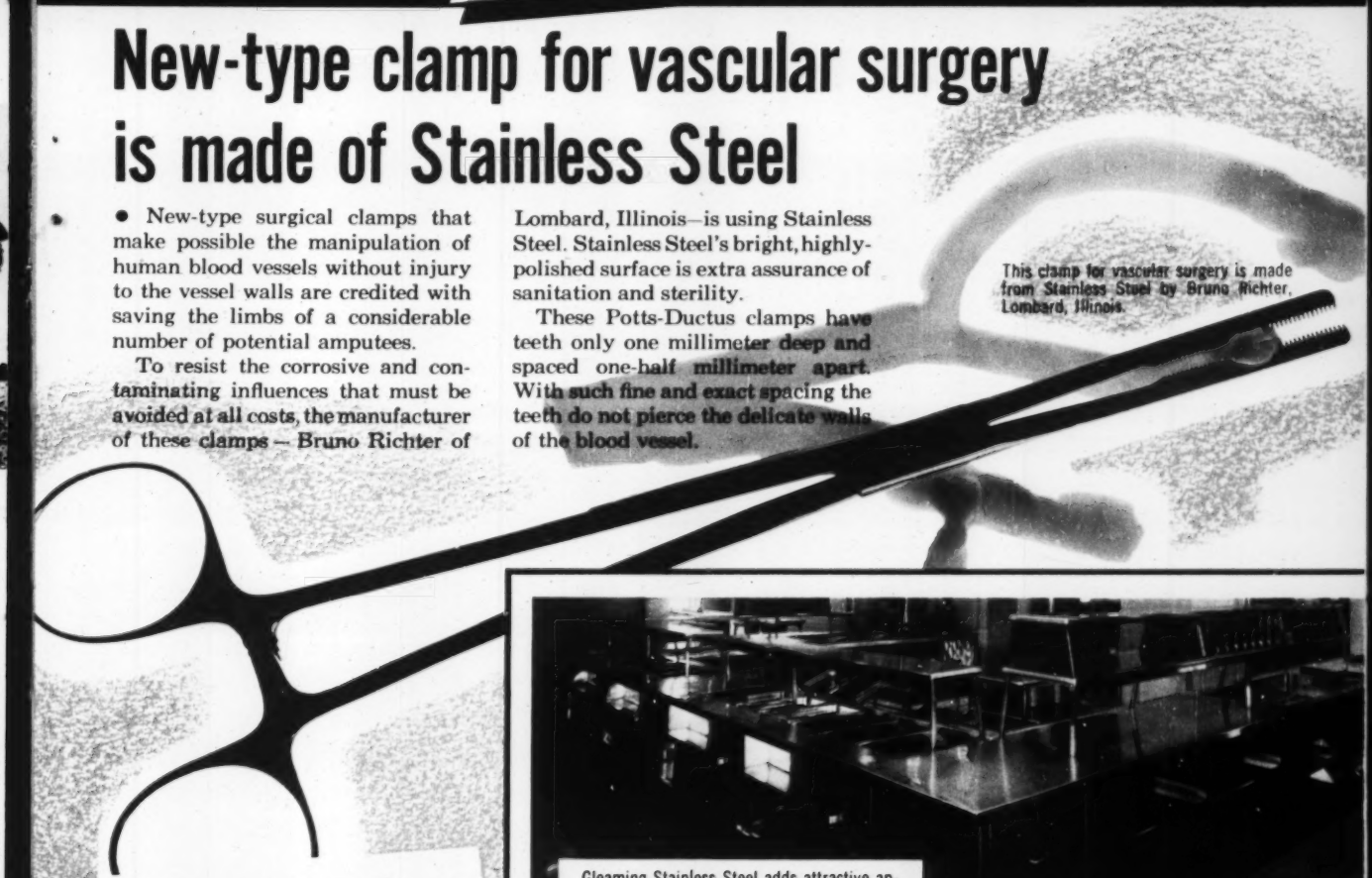
SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

## New-type clamp for vascular surgery is made of Stainless Steel

• New-type surgical clamps that make possible the manipulation of human blood vessels without injury to the vessel walls are credited with saving the limbs of a considerable number of potential amputees.

To resist the corrosive and contaminating influences that must be avoided at all costs, the manufacturer of these clamps — Bruno Richter of Lombard, Illinois—is using Stainless Steel. Stainless Steel's bright, highly-polished surface is extra assurance of sanitation and sterility.

These Potts-Ductus clamps have teeth only one millimeter deep and spaced one-half millimeter apart. With such fine and exact spacing the teeth do not pierce the delicate walls of the blood vessel.



This clamp for vascular surgery is made from Stainless Steel by Bruno Richter, Lombard, Illinois.

### Take advantage of Stainless Steel in your designs and in your selling

Here are more applications typical of the thousands in which Stainless Steel has been used to improve design and add sales appeal. The wide range of valuable properties available in Stainless Steel makes it the ideal material for many, many jobs.

Put Stainless to work for you. It will pay its own way and give you a good return on your investment—especially when it is perfected, service-tested U·S·S Stainless Steel.

Gleaming Stainless Steel adds attractive appearance and a host of other benefits to the employee cafeteria at H. J. Heinz Company, Pittsburgh. It was fabricated by Tyson Metal Products Company, Pittsburgh.

## Stainless Steel's ease of cleaning makes it best for cafeteria use

Food handling is a "natural" for Stainless Steel. Stainless gives you an unmatched combination of sanitary qualities, ease of cleaning, a smooth, non-porous surface, resistance to corrosion and long life.

This cafeteria equipment was fabricated for H. J. Heinz Company, Pittsburgh, Pa., by Tyson Metal Products Company, Pittsburgh. It is made of a nickel-chromium grade of Stainless Steel.

USS

UNITED STATES STEEL CORPORATION, PITTSBURGH · COLUMBIA GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS

UNITED STATES STEEL

fabricated and erected by Blaw-Knox

# high pressure crossover piping

## . . . in large power plant

Whether you need a complicated, high pressure piping system, such as this one, or a relatively simple job, you can always turn the entire job over to us. And we'll follow through . . . in close cooperation, of course, with your consultants or your own organization.

You'll get the benefit of modern shop facilities for hot and cold bending, welding and fabricating all types of piping. A metallurgical research laboratory which assures you of the latest developments in high pressure, high temperature piping. The most modern testing equipment to assure the soundness and strength of the piping.

Plus a complete service force with modern machinery for field work and erection . . . and the necessary manpower to handle jobs of any size.

To get more information on piping for industry write for your copy of Bulletin No. 2443.

### What service do you require?

We will, for instance, (1) engineer, fabricate, and erect your job . . . or (2) simply fabricate and erect . . . or (3) fabricate only.

Our engineers will quote from your drawings . . . or, when desired, make a field study of your piping requirements before quoting.

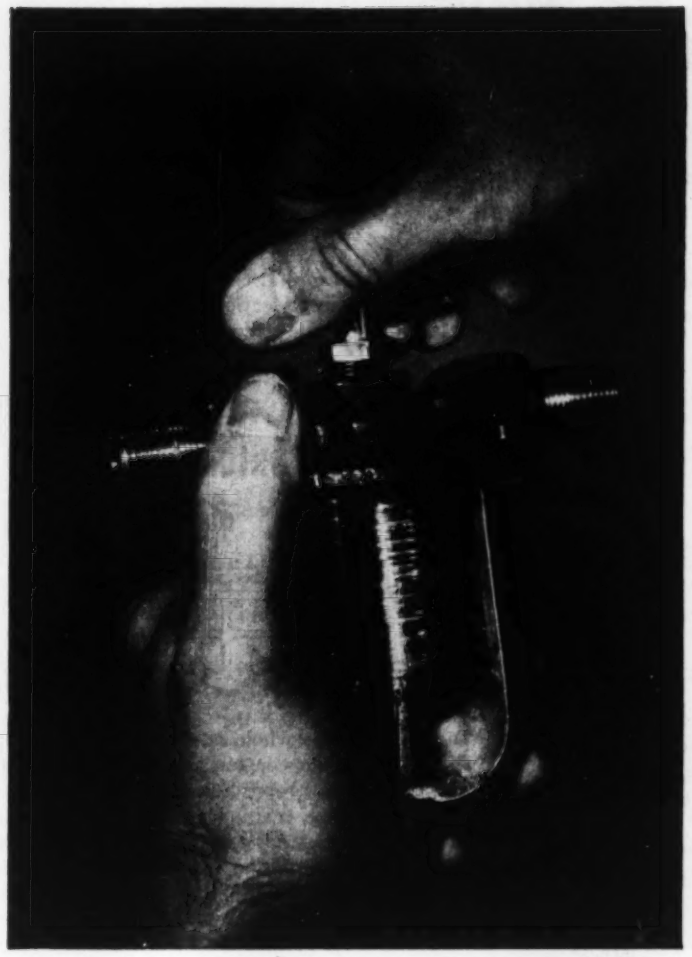
Just let us know what service you want . . . and we'll provide it.

**BLAW-KNOX COMPANY**
*Power Piping and Sprinkler Division*
*Pittsburgh 33, Pa.*

BLAW-KNOX

## POWER PIPING

Complete prefabricated power piping systems for all pressures and temperatures . . . plus complete line of functional spring hangers • rigid hanger assemblies • overhead roller assemblies • supports • vibration eliminators



## JUST A twist OF THE wrist

That's all it takes to clean the Cuno AUTO-KLEAN—the strainer that can be continuously cleaned while it's working.

Turning the handle one revolution moves the strainer element through comb blades, removing all dirt from strainer surfaces. Dirt particles fall to bottom of housing, where they can be drained off periodically. Cuno's exclusive combing operation cleans thoroughly—without costly interruption of fluid flow.

- AUTO-KLEAN's permanent metal filter element is available in steel, brass or stainless steel for long trouble-free service under any conditions.
- AUTO-KLEAN is adaptable to any fluid-flow system.
- From acids to tar . . . if you can pump it, Cuno can filter it. Capacities range from one gallon per hour to 3,800 gallons per minute.

A.3.8

CUNO ENGINEERED FILTRATION
Removes More Sizes of Solids From More Kinds of Fluids

AUTO-KLEAN (disc-type) • MICRO-KLEAN (fibre cartridge) • FLO-KLEAN (wire-wound)

# HERE'S HOW TO GET LOW-COST FLUID FILTRATION

### Continuously cleanable AUTO-KLEAN eliminates need for stand-by strainers

You don't have to install a duplex strainer system to get all the dirt and other solids out of your process fluids, coolants, chemicals, water, lube oils or hydraulic fluids. A *single* Cuno AUTO-KLEAN strainer will do the job to your complete satisfaction.

This is possible because you don't have to shut down your fluid-flow system to clean this strainer. Cuno's exclusive "comb-clean" action provides complete cleaning of the strainer element on the job—*without stopping fluid flow.* Thus you get non-stop filtration, with no need for a stand-by strainer.

AUTO-KLEAN also saves on maintenance bills, for there aren't any cartridges to change. An occasional rotation of the handle does a thorough cleaning job. (Most units can be equipped with motor-drives for continuous cleaning.)

AUTO-KLEAN is extremely compact. It will give you full-flow filtration in space which would limit ordinary filters to by-pass service. The low pressure drop operation of AUTO-KLEAN permits this full-flow filtration on gravity, low-pressure or high-pressure lines—with no loss in operating efficiency.

AUTO-KLEAN's fixed-space metal discs will stop all solids larger than the specified disc spacing—from .0035" (170 mesh) to .062" (12 mesh).

Find out today about AUTO-KLEAN. Send the coupon for free bulletin.

A.3.14

Cuno Engineering Corporation
Dept. 6514B, South Vine St., Meriden, Conn.
Please send me your free bulletin on Cuno AUTO-KLEAN
for ..... (fluid)
Name .....
Company .....
Address .....
City ..... Zone .... State .....

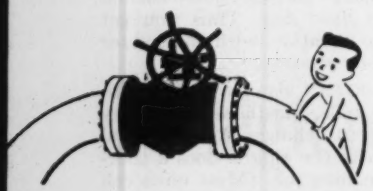
# Let's Face the Facts...

# DOES VALVE LUBRICATION

*Now and then someone revives an old argument—"it costs too much to maintain lubricated valves."*

*On the surface, that sounds logical. But if that really was a fact, millions of Nordstrom lubricated valves in service today* could never have been sold.*

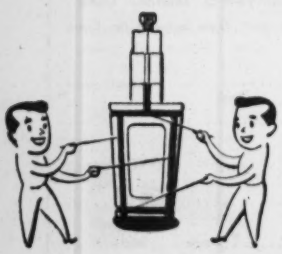
## WHAT IS THE ADVANTAGE OF A LUBRICATED VALVE?



The most important function of lubricant in a Nordstrom valve is to give a tighter seal than can be accomplished through any other method yet developed. The thin film of plastic lubricant that is forced around the ports of the plug is a pressure seal in itself.

Of course, the lubricant has other obvious advantages—the same advantages it has in your automobile, or in any other mechanical equipment where metal rubs metal. The lubricant all but eliminates the possibility of galling or seizing, and consequently keeps the valve ready to operate in a hurry. A lubricated Nordstrom valve operates easily even against high line pressures, because the plug turns *within* the line, rather than being forced or wedged *against* it. Since it takes only a quarter turn of the plug to open or close the valve, it operates in seconds instead of minutes.

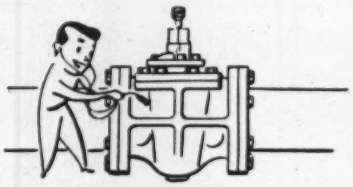
## WHAT DOES THE LUBRICANT DO?



In a Nordstrom valve, lubricant is forced through a series of grooves surrounding the plug ports. There it acts as an extra seal against the little leaks that become big problems. It is also forced into a lubricant chamber at the small end of the plug where it serves as a hydraulic jack to keep the plug easy to turn.

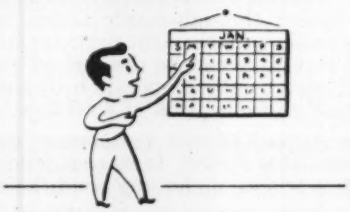
Finally, it *lubricates* . . that is, it prevents grinding wear, fills tiny imperfections that may develop, and it lets the plug slide without grating.

## WILL A NORDSTROM VALVE WORK WITHOUT LUBRICANT?



Yes, but then the whole advantage of a lubricated valve is lost. Your car will also operate without lubricant, but with proper lubricant, it is far more efficient, lasts many, many times longer, needs much less maintenance, and is safer. So is a valve. Nordstrom is fundamentally a valve—a plug valve made to exceptional standards of tolerance and quality—but it is the internal Nordstrom lubrication system which raises its performance standards above ordinary valves.

## HOW OFTEN SHOULD NORDSTROM VALVES BE LUBRICATED?



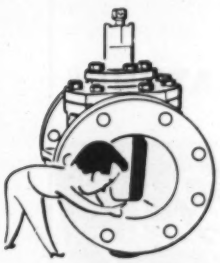

Like your car, that depends upon the service—the temperature, process, frequency of operation, etc. It's hard to generalize, but your Nordstrom sales engineer can advise you. Using Rockwell lubricants, made especially for Nordstrom valves, is one way to reduce frequency of lubrication in many cases. Also, Rockwell markets mechanical lubrication equipment to make scheduled lubrication easy. Nordstrom Hypreseal valves are now built with an external fitting so that it is unnecessary to remove any parts from the valve before lubrication.

# COST MONEY OR SAVE MONEY?

## WHAT LUBRICANTS SHOULD BE USED?

Part of the effect of lubricating your car is lost if you use improper lubricants. That is also true of lubricated valves. Genuine Rockwell lubricants will save you money—they are the result of the longest and most extensive research into valve lubricants by any company. They are the result of years of field experience with nearly every process condition. For many services there are variations of Rockwell lubricants compounded to offset specific line conditions. Also, for many services Rockwell Hypermatic lubricant may be recommended. This lubricant, which is compressible and energizable, regenerates itself in the lubrication system, greatly reducing lubrication frequency. In any case, consult your Nordstrom sales engineer.

## HOW LONG WILL PROPERLY LUBRICATED NORDSTROM VALVES LAST?



That's impossible to answer, since many of the first Nordstrom valves put into regular service are still going strong. The service has a lot to do with it, naturally. In gas service, there are many valves with more than 30 years service. In the valve-killing application of drilling rig mudlines, Nordstrom valves have been disassembled for inspection after more than 150,000 feet of hole on many occasions, found to be without wear, and returned for more service—often four times the life of ordinary valves. In a two-year paint plant test, Nordstrom valves were the only ones that did not need to be replaced because of leakage. Nordstrom files are full of such authentic field case histories—ask your Nordstrom sales engineer.

## WHAT ABOUT MAINTENANCE COSTS FOR NON-LUBRICATED VALVES?

In any but the most simple services, any kind of valves need *some* maintenance. But in the case of Nordstrom valves, maintenance is generally confined to adding lubricant at intervals. Over a 20-year period, Nordstrom sales of repair parts have been less than half of one per cent of sales. In several plants in which records were kept and where Nordstrom and other valves were used, repair parts for Nordstrom valves ran about one-tenth of other makes.

The analogy to your car carries over here—if you don't lubricate it, you save on lubricant, but pay the far, far higher costs of part replacement. And more particularly, you'll need a new car much more often.

When you consider valve maintenance, be sure to count *all* the costs—not just simple service, but major repairs and complete replacement costs, shutdowns, extra labor to operate, and *all* factors.

If you do, if yours is a typical application, you'll find that year-in and year-out, the most economical valves you can use are Nordstroms.

If you'd like to discuss the suitability of Nordstrom valves for any service, let us know. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

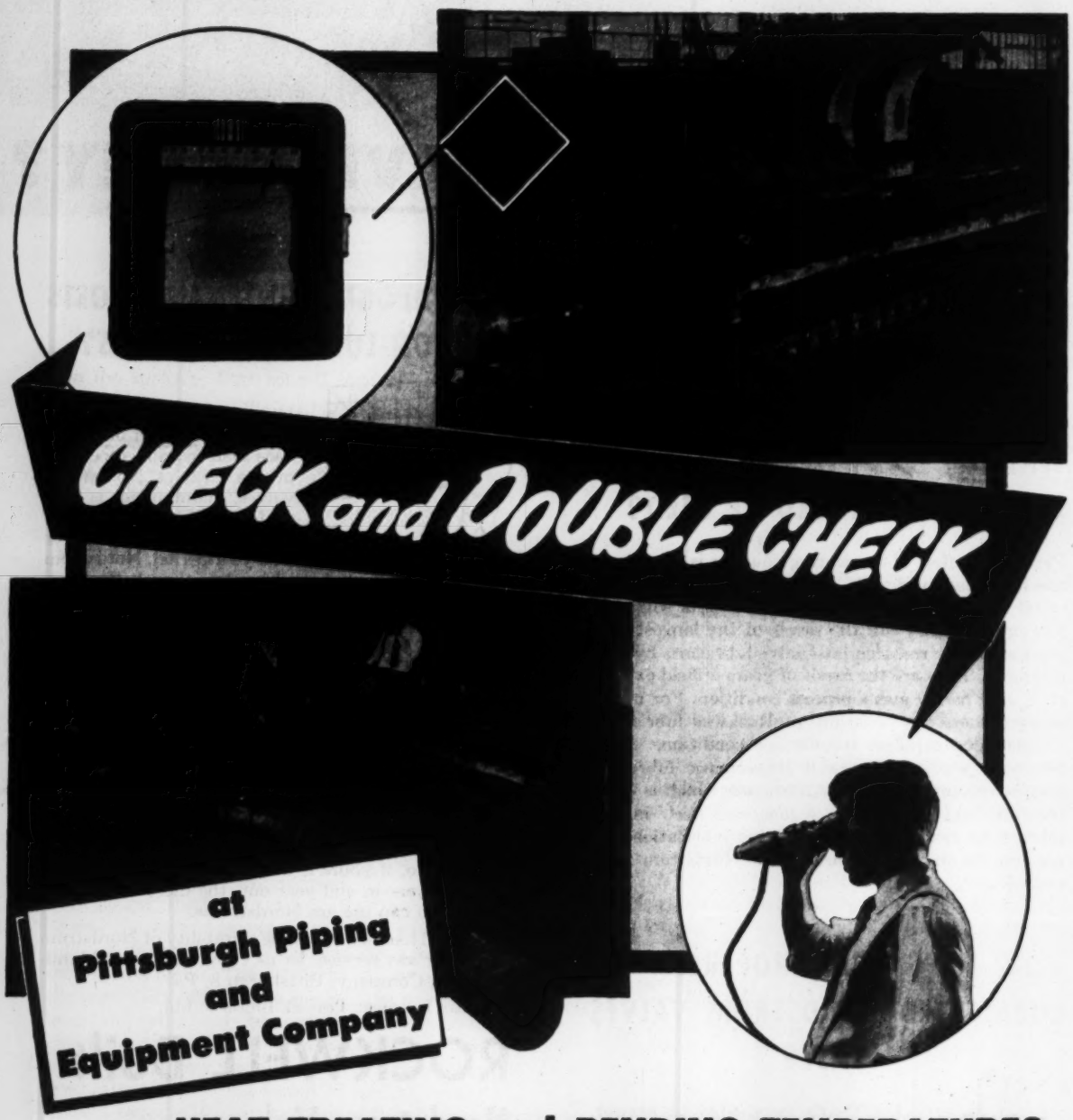
Canadian Licensee: Peacock Brothers, Ltd.

# ROCKWELL Built

## Nordstrom Valves

*Lubricant-Sealed for Positive Shut-Off*

* Nordstrom invented lubricated valves more than 30 years ago. Since that time, several million have been installed in hundreds of widely varied petroleum, gas, chemical and other process services. With by far the most complete range of sizes and pressures, and many patents on construction details, Nordstrom is the leader in lubricated valves.




## on HEAT TREATING and BENDING TEMPERATURES

The temperature to which P.P.&E. piping is subjected before bending is measured by a Ray-o-Tube which projects through the furnace wall . . . and recorded on the chart of the Micromax instrument.

This time-temperature record makes practicable precise control of conditions so that each section of pipe is heated in conformance with a predetermined routine which assures consistent physical and mechanical properties.

After the pipe is taken from the furnace, it is immediately placed on a bending table, and during the bending process its temperature is periodically checked with an optical pyrometer by a trained, experienced observer.

You can depend on Pittsburgh Piping and Equipment Company for leadership in methods that assure greatest safety, highest efficiency, and longest service from high temperature, high pressure piping.

**Pittsburgh Piping**
**AND EQUIPMENT COMPANY**
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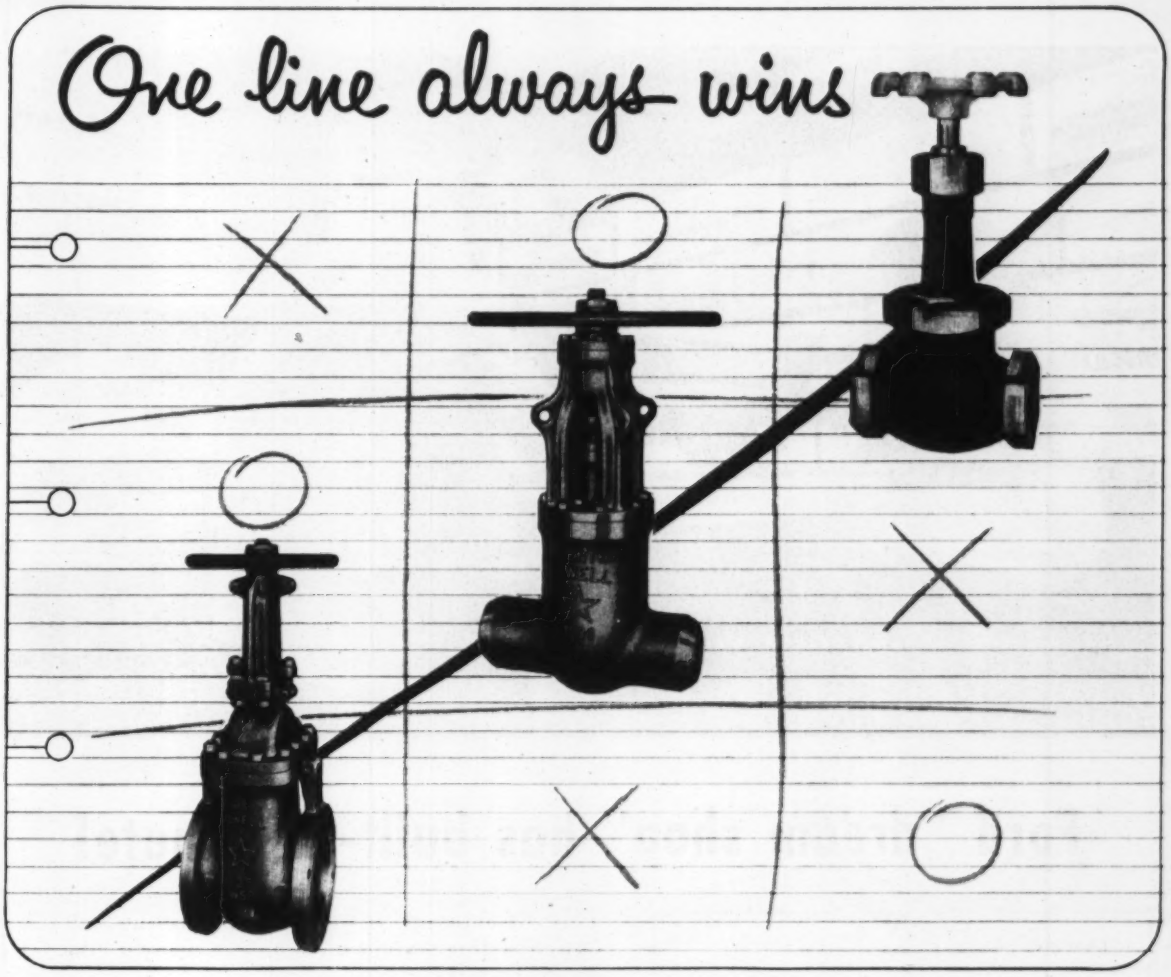
Charlotte 221 Builders Building Los Angeles 1830 N. Alexandria Ave.
Chicago Peoples Gas Building New Orleans P. O. Box 74
New York Woolworth Building

pp. 1

# One line always wins



TOP

**BRONZE "W.S." FULL FLOW GLOBE VALVE** *(Fig. 2608)* for 200 pounds W.P. Regrindable, renewable, hardened stainless steel seat and disc. Nominal pipe size opening through seat permits fuller flow, with pressure drop and turbulence cut to minimum.

CENTER

**PRESSURE SEAL CAST STEEL GATE VALVE** *(Fig. 11303).* 1500 pounds. Many proven advantages and exclusive features. Pressure Seal Valves are also available in Non-Return, Check, Globe and Angle Patterns for 600, 900, 1500, 2500 pounds.

BOTTOM

**"MODEL STAR" GATE VALVE** *(Fig. 1793)* for 125 pounds W.P. Iron body, bronze mounted. Supplied with taper solid wedge. Sizes 2" to 30", inclusive.

There's never any doubt about what tack to take in choosing the winning line of valves. It's Powell! For Powell Valves are manufactured up to The William Powell Company standards of quality—standards that have kept rising for more than a century.

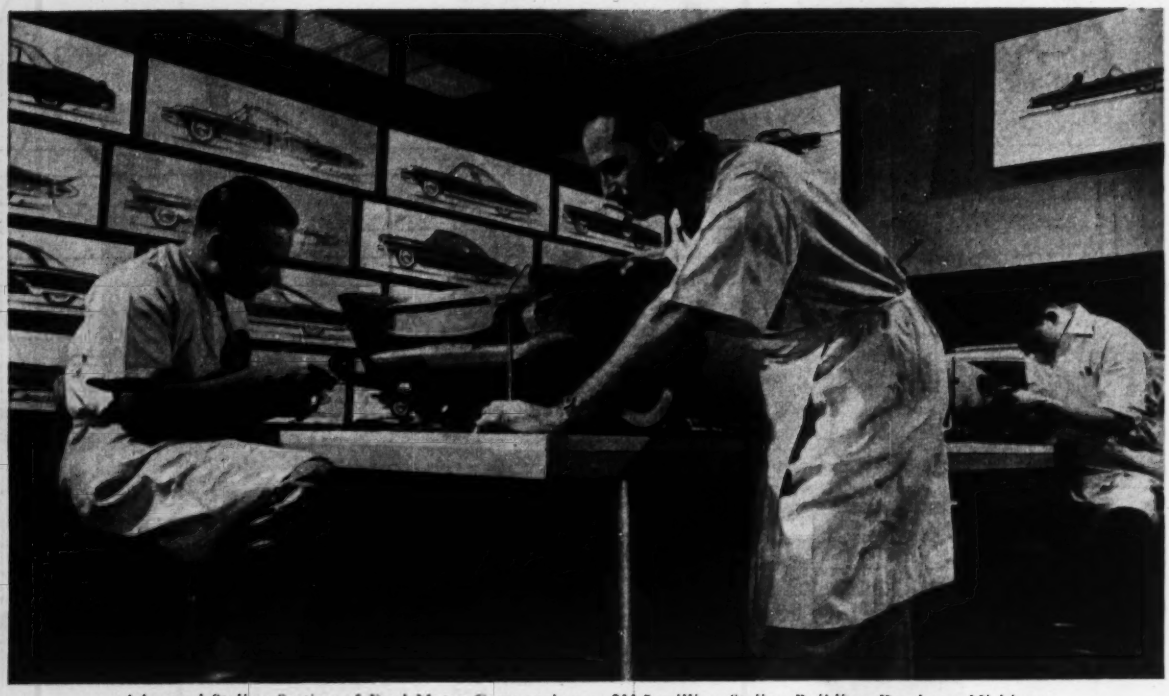
What's more, Powell has a *complete line*—probably manufacturing more types of valves than any other organization in the world.

Powell Valves are available through distributors in principal cities. If a distributor is not located near you, just write us. We'll be pleased to tell you about our complete line and answer your questions. Answering questions is a specialty at Powell where solving valve problems has built the world's most valuable background of sound solutions.

**CONTROLS FOR THE LIFE LINES OF INDUSTRY**

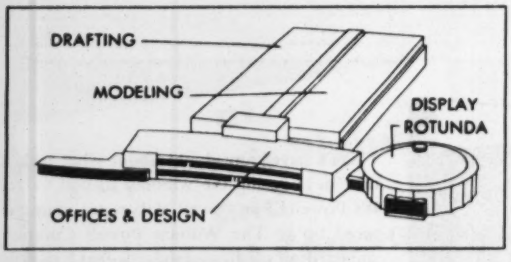
*..... 108th YEAR*

THE WM. POWELL COMPANY · CINCINNATI 22, OHIO



Advanced Styling Section of Ford Motor Company's new $11.5 million Styling Building, Dearborn, Michigan.

# Ford "dream shop" has built-in climate!




The design-office wing and display rotunda are served by a central system. It includes: 7 supply fans; 34 exhaust fans; heating and cooling coils and sprayed-coil dehumidifiers – all furnished by American Blower.

Air for drafting rooms and modeling studios is conditioned by 24 specially built, automatically controlled American Blower Air-Conditioning Units. Each unit contains heating and cooling coils and capillary air washers.

This "dream shop" at the Ford Engineering Staff's Advanced Styling Section is just one of many styling areas which depend on clean, conditioned air.

For example, in 12 roomy studios clay-modeling teams work under lights which produce shadowless illumination – and intense heat! To absorb this heat and provide the proper climate for working with clay models, specially designed air-conditioning systems were installed for each studio and drafting room. American Blower Air Handling and Air-Conditioning Equipment was used for this unusual assignment.

The expert know-how of American Blower engineers is on tap for industry at all times. If you have an air-handling or air-conditioning problem, phone your nearest American Blower or Canadian Sirocco Branch Office.

**AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN**
**CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO**
Division of American Radiator & Standard Sanitary Corporation

**AMERICAN BLOWER**

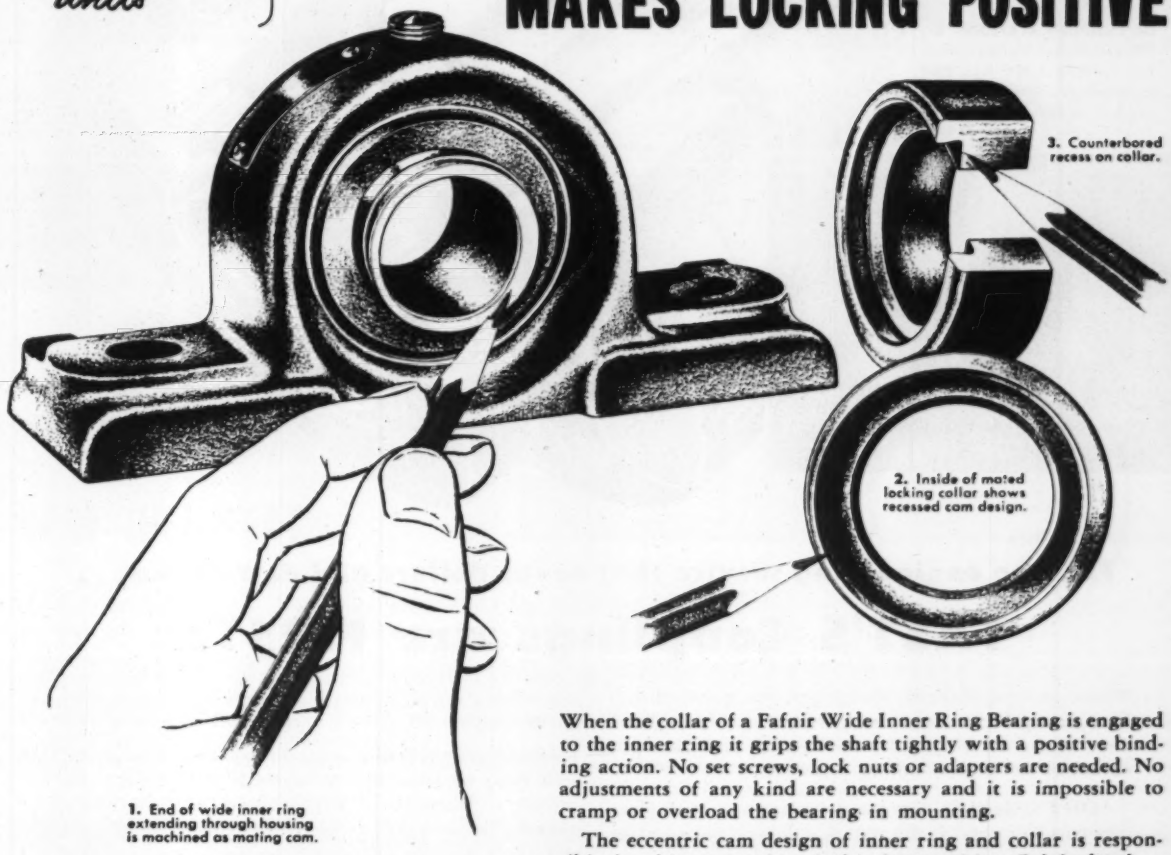
*Serving home and industry:*
AMERICAN STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS • SUNBEAM AIR CONDITIONERS

*preference points on power transmission units*

# ECCENTRIC CAM DESIGN

## of Inner ring and collar

# MAKES LOCKING POSITIVE

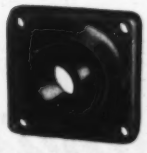

3. Counterbored recess on collar.
2. Inside of mated locking collar shows recessed cam design.
1. End of wide inner ring extending through housing is machined as mating cam.

When the collar of a Fafnir Wide Inner Ring Bearing is engaged to the inner ring it grips the shaft tightly with a positive binding action. No set screws, lock nuts or adapters are needed. No adjustments of any kind are necessary and it is impossible to cramp or overload the bearing in mounting.

The eccentric cam design of inner ring and collar is responsible for this extremely valuable feature. It's a Fafnir development . . . tried and proven over the years. Shaft scoring is no longer a problem . . . and shaft slippage is out. The Self-Locking Collar transmits all thrust loads to the bearing.

For straight shaft mounting, the Fafnir Wide Inner Ring Bearing with Self-Locking Collar continues to rate "tops" as a feature of power transmission units. Every day it makes possible greater simplicity of mounting, economy of design, assembly and maintenance costs. For complete information call your Fafnir Representative. The Fafnir Bearing Company, New Britain, Conn.

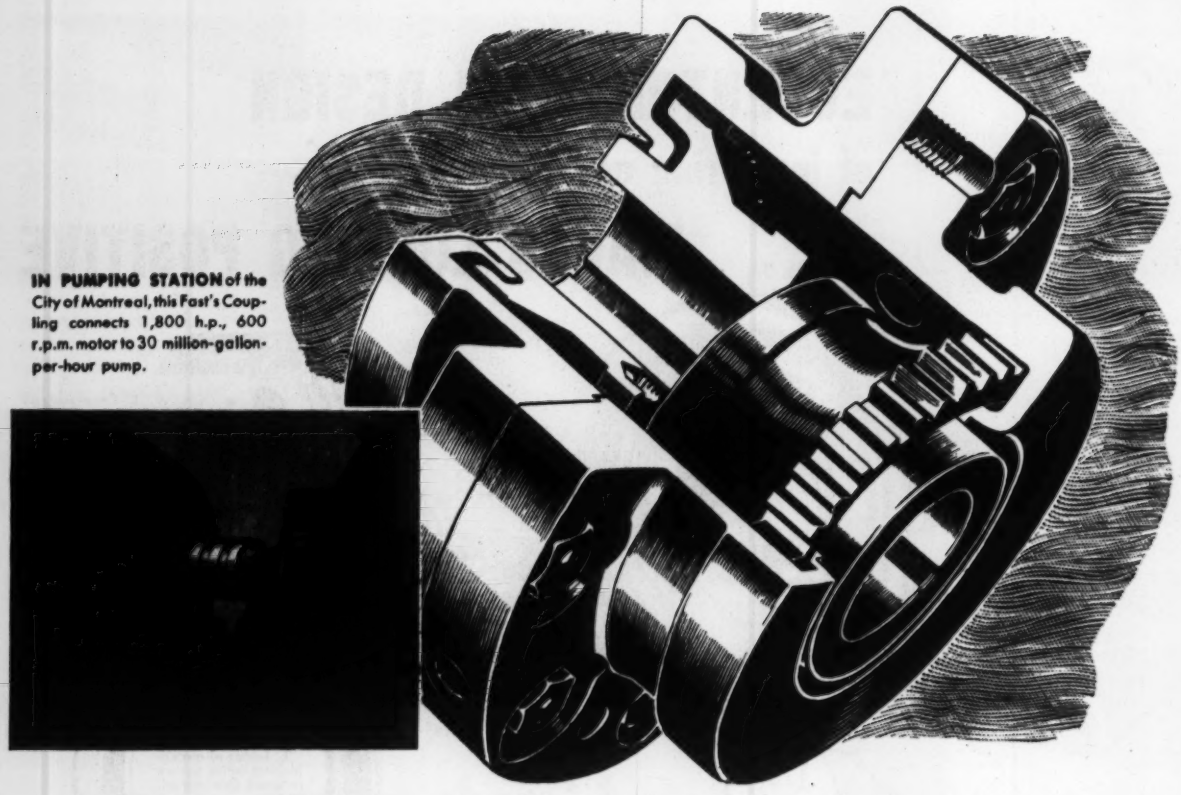
**PILLOW BLOCKS** . . . standard and heavy series



**FLANGE CARTRIDGES** . . . standard and heavy series

**CYLINDRICAL CARTRIDGES** . . . . standard and heavy series

**WIDE INNER RING BALL BEARINGS** . . . with Mechani-Seals



**IN PUMPING STATION** of the City of Montreal, this Fast's Coupling connects 1,800 h.p., 600 r.p.m. motor to 30 million-gallon-per-hour pump.

**For free engineering service that saves dollars and down-time . . .**

# FAST'S Couplings are FIRST!

When you specify Fast's Couplings, you get the benefit of Koppers *free engineering service* . . . your assurance of the right coupling for any job and the right solutions to tough coupling problems.

FOR EXAMPLE: "Get the drawings and send them down to Koppers" is the standard answer in one plant whenever a tough coupling application arises!

FOR EXAMPLE: After studying a list of spares for stand-by units made up by one customer, a Koppers sales engineer eliminated duplications . . . resulting in a smaller order for him but a *much smaller inventory* for the customer!

Add the *rugged construction* of Fast's Couplings . . . with their original design maintained without basic change or sacrifice in size or materials. Add their lowest cost per year . . . their life expectancy guarantee. *Fast's usually outlast the equipment they connect.* Result: it will pay you to write today for full details on how Fast's Couplings and Koppers Engineering Service can help you get uninterrupted power transmission! Send for free catalog to: KOPPERS COMPANY, INC., *Fast's Coupling Dept.*, 253 Scott Street, Baltimore 3, Md.

KOPPERS®

THE ORIGINAL

**FAST'S Couplings**

**METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • BALTIMORE, MD.** This Koppers Division also supplies industry with American Hammered Industrial Piston and Sealing Rings, Koppers-Elex Electrostatic Precipitators, Aeromaster Fans and Gas Apparatus.

***Engineered* Products Sold with *Service***

**KOPPERS COMPANY, INC.,** *Fast's Coupling Dept.*, **253 Scott St., Baltimore 3, Md.**

**Gentlemen: Send me a Fast's Catalog giving detailed descriptions, engineering drawings, capacity tables and photographs.**

**Name** .....

**Company** .....

**Address** .....

**City** ..... **Zone** ..... **State** .....

# Make Office Photocopies in Brighter Light on Peerless DRI-STAT *"Bright-Light" Paper*

**NEW DRI-STAT** "Bright-Light" paper offers, for the first time, office photocopying that truly deserves the name. Developed by Peerless Photo Products, Inc., DRI-STAT "Bright-Light" paper allows you to make sharp, clear, black-and-white photocopies of any original, under the normal levels of illumination in today's modern offices . . . fluorescent or incandescent light of fairly high intensity, or subdued daylight. Here, at last, is a paper that will give you good results under four to five times more light than you could ever work in before.

Now you can really make full use of transfer-process photocopying . . . the modern, quick, inexpensive method of making exact copies of anything written, drawn, or printed . . . anywhere in your office. No longer need you put up with the inconvenience of having to locate your photocopy equipment in an out-of-the-way corner, a stuffy closet or a crowded stockroom. When you use the new DRI-STAT "Bright-Light" paper, you can put your photocopy equipment right where you want it . . . right where it's most convenient and comfortable to use . . and get sparkling, clear, black-and-white copies, regardless of room illumination.

DRI-STAT papers give these amazing results not only on DRI-STAT equipment, but with almost every other type of transfer-process photocopying equipment now on the market. If you already have such equipment, try DRI-STAT papers and see the improvement!

### You Save Time and Money with DRI-STAT

You can copy originals up to 11" by 17" in size on DRI-STAT equipment, or continuous strip matter up to 12" wide. Results are equally good from opaque or translucent originals, since copying can be done either by the reflex or the contact method.

DRI-STAT vellum paper can be used to produce a translucent "master" from which multiple copies can be reproduced by the diazo process.

DRI-STAT equipment takes up less space than a typewriter, can be used right in the department (or branch office) where photocopies are needed. The originals never leave your possession. Copies are ready in less than one minute, cost less than 10 cents apiece.

### Convenient, Easy to Use

Anyone in your office can quickly learn how to make good DRI-STAT copies. No extra help with special training is needed. No darkroom is needed, and there are no messy trays of developing solution.

DRI-STAT papers and equipment are wholly manufactured in the United States, which means consistent quality and dependable delivery. DRI-STAT is sold only through factory-trained Peerless distributors, all of whom are well qualified to give you professional counsel on your reproduction methods.

### Ask for a Demonstration

Try DRI-STAT papers on your own work. For a demonstration, call or write your Peerless distributor, or clip and mail the coupon below.

DRI-STAT

DRI-STAT Division
PEERLESS PHOTO PRODUCTS, Inc.
Shoreham, Long Island, New York

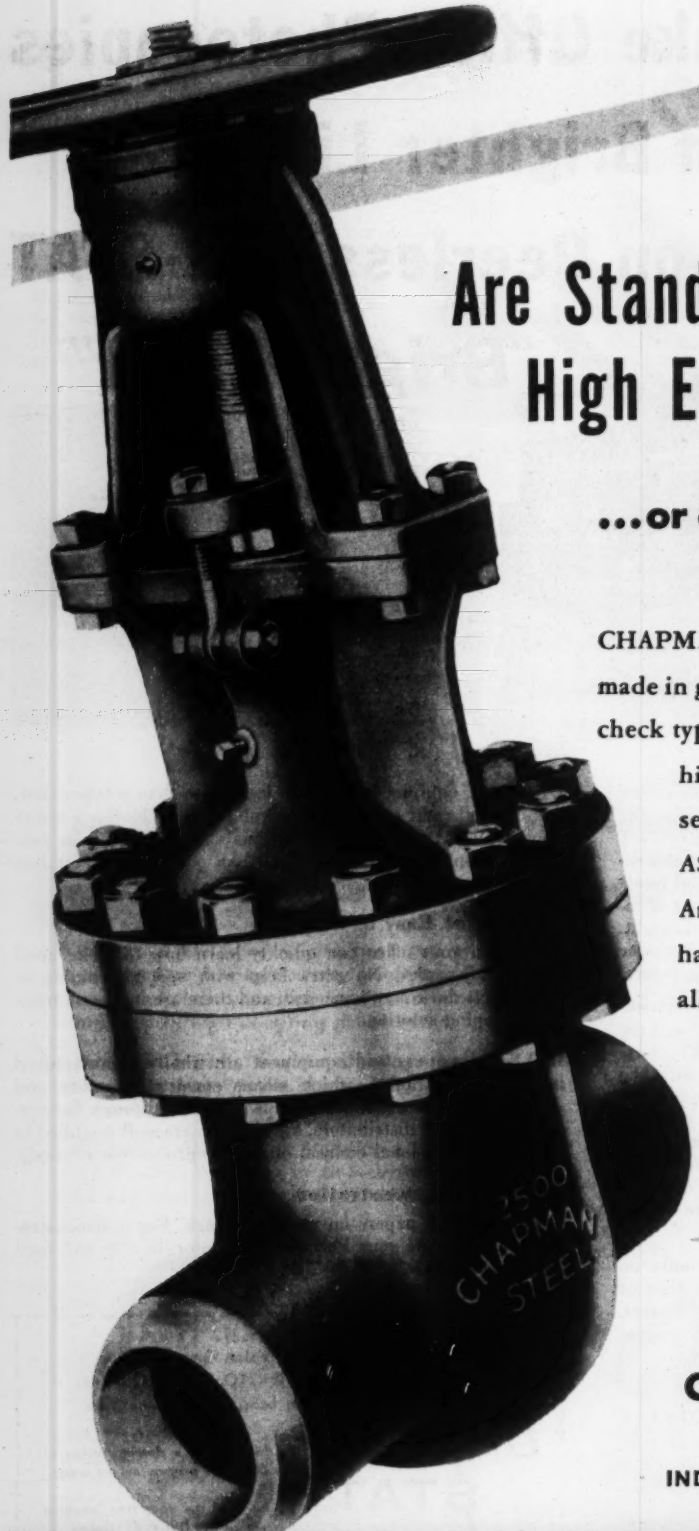
☐ I'd like to see a demonstration of the DRI-STAT process on my work.

☐ Please send me your free brochure describing the DRI-STAT papers and equipment.

Name.....ME 3

*(Clip or staple to your business card or letterhead)*

***Send the coupon today for full details →***




# Are Standard Pressures High Enough For You

## ...or do you need *special* steel valves?

CHAPMAN CAST STEEL VALVES are made in gate, globe, swing and tilting disc check types . . . to handle the most severe high-pressure, high-temperature services. These valves are made to ASA and API ratings in all sizes. And on the special side, Chapman has everything needed to develop alloys and designs for *any* requirement. Do *you* have Catalog 20?

**THE CHAPMAN VALVE MFG. CO.**

INDIAN ORCHARD, MASSACHUSETTS

**YEAR BY YEAR, CHAPMAN WRITES NEW CHAPTERS IN METALLURGY AND FLOW-CONTROL**

# 2 Waldes Truarc Rings Replace 2 End Plugs ...Eliminate 3 Operations...Save $.066 Per Unit

**OLD WAY** Two inserted-plug type wrist pin locks hold wrist pin in place. 3 operations involved: costly machining, pressing in place, post-assembly machining. Costly maintenance problem—resulting from end plugs hammering loose.

**TRUARC WAY** Two Truarc Inverted Retaining Rings (Series 5008) hold wrist pin in place. Truarc Rings snap into grooves easily cut in piston, provide positive lock . . . practically eliminate maintenance costs. Quick assembly, disassembly.

Titan Chain Saws, Inc., Seattle, Washington, uses 2 Waldes Truarc Rings to replace old-style inserted-plug type wrist pin locks in their Titan chain saws. Use of Waldes Truarc Retaining Rings eliminates 2 press fit end plugs. Machining of plugs, pressing in place, finish machining—no longer required. Truarc way holds rejections to a minimum. Unit efficiency is greatly increased.

Redesign with Truarc Rings and you, too, will cut costs. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better job of holding parts together.

Waldes Truarc Rings are precision-engineered . . . quick and easy to assemble and disassemble. Always circular to give a never-failing grip. They can be used over and over again.

Find out what Waldes Truarc Retaining Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

**USE OF 2 WALDES TRUARC RINGS PERMITTED THESE SAVINGS PER UNIT:**

| | |
|---|---|
| **OLD WAY** | |
| Cost of 2 end plugs<br>Cost of pressing in and machining | $ .169 |
| **TRUARC WAY** | |
| Cost of grooving piston<br>Cost of 2 Truarc Rings | .103 |
| **Saving per Unit** | **$ .066** |

**For precision internal grooving and undercutting... Waldes Truarc Internal Grooving Tool.** Visit the Truarc Exhibit at the I.R.E. Show, Booth 746, March 22-25.

**SEND FOR NEW CATALOG**

**WALDES**

# TRUARC

REG. U. S. PAT. OFF.

**RETAINING RINGS**

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 2,382,947; 2,382,948; 2,416,852; 2,420,921; 2,420,361; 2,439,785; 2,441,848; 2,455,185; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,308; 2,509,081 AND OTHER PATENTS PENDING.

ME-036

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.

Please send me the new Waldes Truarc Retaining Ring catalog.

(Please print)

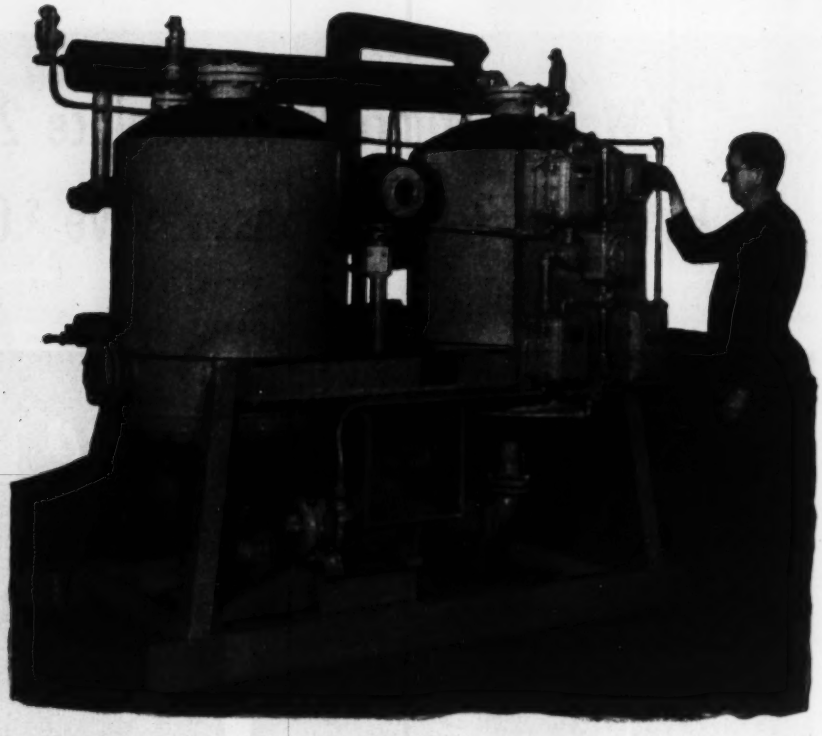
Name .....

Title .....

Company .....

Business Address .....

City ..... Zone ..... State .....



Fully automatic instrument air dryer . . . BY-type Lectrodryer

# DRY AIR and how to get it...

Even on the most arid desert, air is wet! Elsewhere, it's wetter. Hence, if you need dry air, you must use machinery to get it.

A Lectrodryer* is an air drying machine. With it you can dry great volumes of air in a continuous flow to prescribed low dewpoints. You can reduce the moisture content of air to a stable constant!

**Lectrodryer machines can drop air to dewpoints below −100°F . . . reduce relative humidity below 10%.**

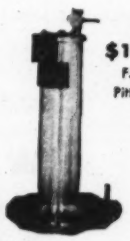
There's probably a Lectrodryer already built that meets your drying need. The largest (for a wind tunnel) dries three tons of air per minute to a dewpoint of −70° F. Smaller machines are preserving the interior of Navy ships of the "Mothball Fleet" by maintaining a constant relative humidity below 30%.

Besides air drying, there are Lectrodryers that dry many gases and organic liquids, handling pressures as high as 6000 psi.

If you use air, give some thought to drying it with a Lectrodryer. Write for *Because Moisture Isn't Pink,* a booklet describing Lectrodryers and how industries have used them. Request also, *The Moisture In Our Atmosphere,* a technical booklet on the nature, behavior and measurement of water vapor. Both are free! Pittsburgh Lectrodryer Corporation, 335 32nd Street, Pittsburgh 30, Pa.

## LABORATORY LECTRODRYER

If your experimentation requires small quantities of dry air or other gases, a Laboratory Lectrodryer will help you greatly. Rated at 100 cubic feet per hour, these machines have in many cases provided the dryness in research that has led to large savings in production.



$155.00 F. O. B. Pittsburgh

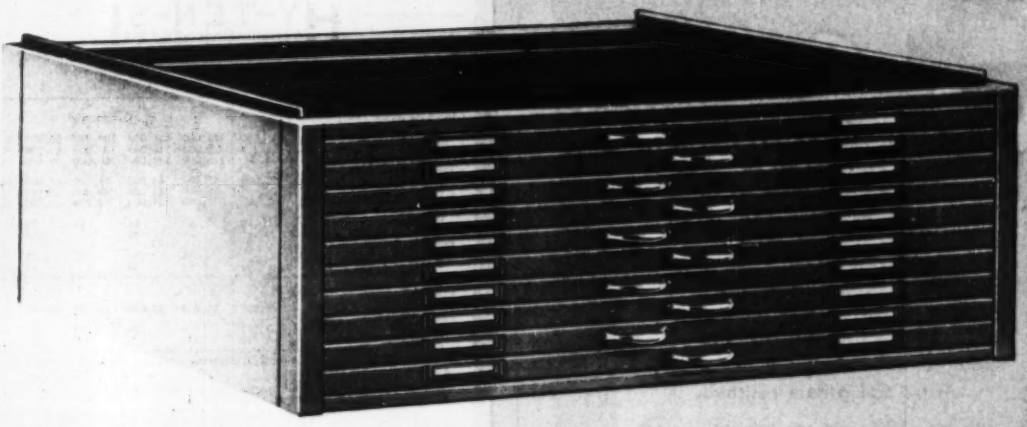
In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue du Moulin, Bressoux-Liege.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

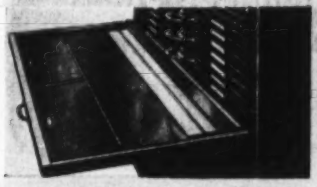
**LECTRODRYER**

*REGISTERED TRADEMARK U. S. PAT. OFF.

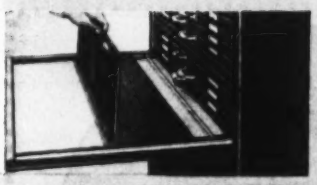
# Keep more tracings safer... handier

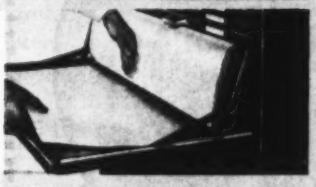


# in Hamilton Shallow Drawer Units

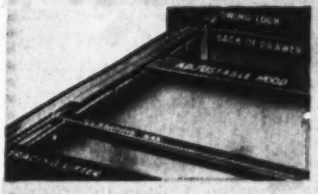


**KEEPS THEM FLAT**
Each drawer equipped with exclusive Tracing Lifter, which also acts as compressor to hold sheets down flat—preventing crumpling, curling, or tearing.





**INSTANT SELECTION**
Front half of Tracing Lifter raises to let sheets be folded over and back, until desired drawing is found and easily slipped out, other sheets remaining in place.

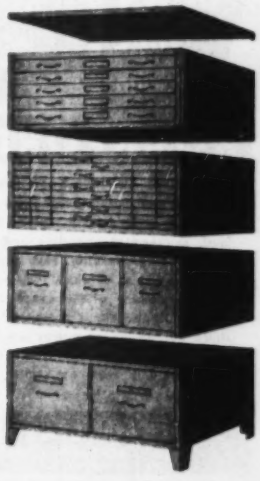


**FITS MANY SIZES**
Conforming to various tracing sizes, adjustable rear hood slides over slotted drawer sides to required depth. Swing bar drops to secure hood—keep sheets from creeping over back of drawer.

There's so much less wear and tear—and *no loss*—when your tracings are kept smooth and flat in Hamilton's popular Shallow Drawer Unit. This 10-drawer unit, only 15⅜" high, holds up to 1,000 drawings safe within its rugged walls of heavy spot-welded steel—yet lets you find any *one* of them instantly!

Hamilton builds outstanding units for every tracing storage need, many units interlocking into one installation—*all* of them likely to save you much money in irreplaceable work and time. Why not contact your Hamilton dealer soon?

**SAVES FLOOR SPACE**
Many Hamilton Units (Shallow Drawer, 5-Drawer, Vertical Units) interlock into single, compact UnitSystem to build storage facilities *upward*. Interlocking caps and bases available.

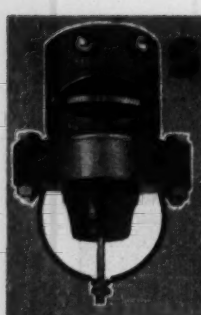


DRAFTING EQUIPMENT DIVISION

**Hamilton**

MANUFACTURING COMPANY

*Two Rivers, Wisconsin*



SOLENOIDS WITH

*Sealed Protection*

***Synchro-Start*** MODEL SS-B SOLENOID in its enclosed casing has the extra protection from any seepages of foreign substances by the addition of a specially constructed boot. This boot is made of a synthetic rubber that is oil and grease resistant.

Also available with the protecting boot is a SYNCHRO-START Solenoid with the standard aircraft A N Connector (Model SS-AB).

*Write for further information*

SYNCHRO-START PRODUCTS INCORPORATED

8151 N. RIDGEWAY AVE. • SKOKIE, ILL.

HERE'S THE STRONGEST BRONZE

HY-TEN-SL

A Bronze as Strong as Nickel Steel

TRADE-MARK

| Grade of HY-TEN-SL | 1AA | 1A | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|
| TENSION | | | | | | |
| Ultimate tensile strength lbs. per sq. in. | | | | (Minimums) | | |
| Sand Cast | 125,000 | 115,000 | 108,000 | 100,000 | 90,000 | 85,000 |
| Rolled 1" and under | ..... | 120,000 | 110,000 | 105,000 | 95,000 | 85,000 |
| Rolled or Forged, over 1" | ..... | 115,000 | 108,000 | 100,000 | 90,000 | 85,000 |
| Yield Point (divider method) | | | | | | |
| Sand Cast | 95,000 | 75,000 | 60,000 | 55,000 | 45,000 | 40,000 |
| Rolled 1" and under | ..... | 75,000 | 65,000 | 60,000 | 50,000 | 45,000 |
| Rolled or Forged, over 1" | ..... | 75,000 | 65,000 | 60,000 | 50,000 | 45,000 |
| Elongation in 2"—% | | | | | | |
| Sand Cast | 10 | 12 | 14 | 15 | 20 | 25 |
| Forged or Rolled | ..... | 12 | 13 | | 15 | 20 |
| Reduction in area—% | | | | | | |
| Sand Cast | ..... | 12 | 14 | 15 | 20 | 25 |
| Forged or Rolled | ..... | 12 | 13 | | 15 | 20 |
| COMPRESSION | | | | | | |
| Yield Point— | | | | | | |
| lbs. per sq. in. | 70,000 | 65,000 | 58,000 | 50,000 | 40,000 | 35,000 |
| Permanent Set at | | | | | | |
| 100,000 lbs. per sq. in. (max.) | .015 | .020 | .030 | .050 | .080 | .125 |
| Brinell hardness, No. | 250 | 240 | 220 | 200 | 175 | 150 |

List of U. S. Government Specifications Covering HY-TEN-SL Bronze

ARMY
Forgings, Rolled Rod QQ-B-721 Class B
Castings...QQ-B-726 Class B and C

NAVY
Forgings and Rolled Rod 46B15d Class B
Castings, Aluminum-manganese Bronze .....46B29

WATERTOWN and OTHER ARMY ARSENALS
Castings .....WXS-5
Forgings and Rolled Rod.....WXS-2

NAVAL GUN FACTORY
Washington Navy Yard
Castings—Trunnion Metal.....O.S.550

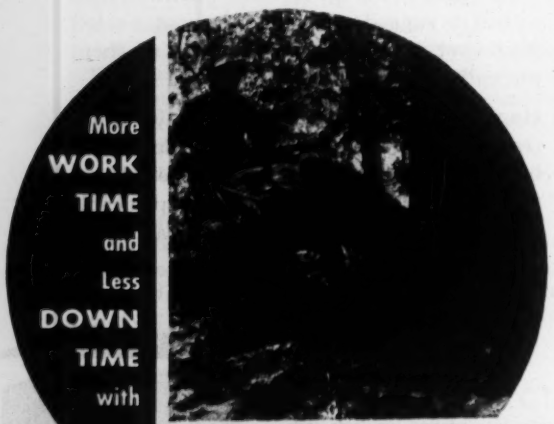
AIRCRAFT
See Navy and Army (above).

*Send for 46 Page "Text Book"*

AMERICAN MANGANESE BRONZE COMPANY

4703 RHAWN ST., PHILADELPHIA 34, PA.

*Established 1909*

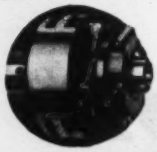


More WORK TIME and Less DOWN TIME with

ROCKFORD CLUTCHES

ROCKFORD CLUTCHES are factory, field and road tested to make sure they will stand up under the torque, shock load, engagement frequency and duration, slippage, reversal, etc., required by the machines in which they are to operate. Because of this exacting on-the-job application, down-time for clutch adjustments or repairs has been reduced to a minimum. Let ROCKFORD engineers help you get more work time from your machines.

ENGINEERING MAKES IT WORK... PRODUCTION MAKES IT AVAILABLE



Send for This Handy Bulletin

ROCKFORD CLUTCH DIVISION BORG-WARNER

1307 Eighteenth Avenue, Rockford, Illinois, U. S. A.

Write for Catalog 700

External Adjustments No Tools Required

MERCOID® PRESSURE CONTROLS

Ranges Available from 30" Vac. to 2,500 PSI. Fully Adjustable as to Range and Sensitivity. Bourdon Tube Operated —Visible Calibrated Dial. Mercoid Sealed Mercury Contact —Immune to Dust-Dirt-Grease-Corrosion-Pitting-Sticking.

THE MERCOID CORPORATION

4201 BELMONT AVENUE, CHICAGO 41, ILLINOIS

# *"Have you thought of steel tube?"*

"I've been thinking of the points you mentioned and, frankly, I am sure Wolverine electric-welded steel tube will do everything you want and save you money to boot!"

"That's fine, but what about finishing."

"Look at this sample. You can paint it, or if your operations call for plating, you can get it in a suitable finish for that, too. On top of that, electric-welded steel tube is strong, easy to fabricate, and simple to join by soldering, welding or other fastening methods."

"Steel tube might be the answer at that."

"And Wolverine's quality control program is a standout bonus! Their reputation for making tubing to close tolerances and with uniform wall thicknesses assures you continuing product satisfaction."

***IF QUALITY IS A "BUY WORD" IN YOUR PLANT:*** Wolverine is the tube for you. Remember it's available in these analyses: SAE 1010, SAE 1015, SAE 1020, SAE 1025, SAE 1030. And in these size ranges: condenser and heat exchanger tube—½" through 2" O.D.; boiler tube—½" through 3" O.D.; and mechanical tube —¼" through 3" O.D.

Write for a copy of our new steel tube catalog today! WOLVERINE TUBE DIVISION of Calumet & Hecla, Inc., 1483 Central Avenue, Detroit 9, Michigan.

**WOLVERINE TUBE DIVISION**
OF CALUMET & HECLA, INC.
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*Manufacturers of Quality-Controlled Tubing*

PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA • Sales Offices in Principal Cities

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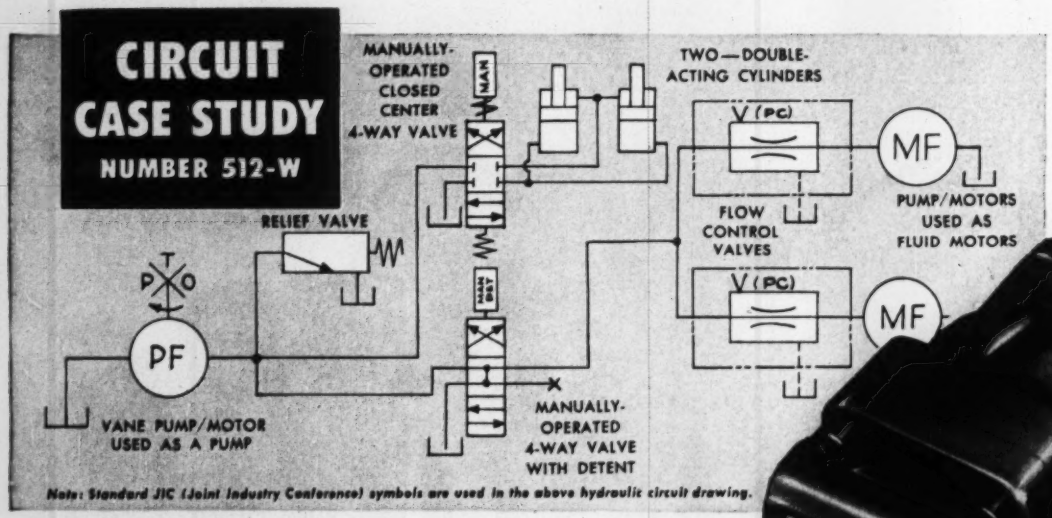
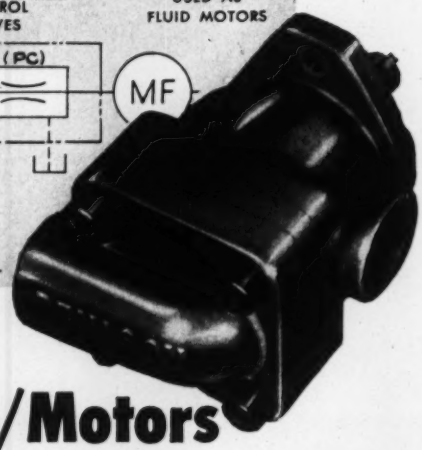

CIRCUIT CASE STUDY
NUMBER 512-W



Note: Standard JIC (Joint Industry Conference) symbols are used in the above hydraulic circuit drawing.



# Underwater weed-cutters powered by DENISON HydrOILic Pump/Motors

## Unusual Circuit Also Features Denison Valves and Controls

Denison Controls and **Pump/Motors** power triple cutter bars in a fleet of boats specially developed to clear shallow inland waterways of weeds and other vegetation.

The circuit, shown above, affords positive control and power to three cutter bars, mounted on each side and across the bow of the boats. It replaces a complex, hazardous mechanical setup of open, rotating shafts, gears, pulleys, chains and belts.

The gasoline engine which powers the boat also drives a Denison **Pump/Motor** which acts as a pump.

Two additional **Pump/Motors**, one at the rear of each side-mounted cutter bar, drive the cutters through 5-to-1 reduction gearing and eccentrics. Drive rods delivering power to the cutters are interconnected by bell cranks.

A Denison 4-way valve, with detent, controls these two **Pump/Motors**. The detent permits the operator to leave the valve in either the "operating" or "off" position without holding the lever.

A Denison relief valve limits system pressure to the maximum pre-set rating. The mechanical linkage formerly used was subject to severe damage if the cutters struck an obstacle. Now, however, the cutters merely stall, and excess flow "spills" through the relief valve.

A second Denison 4-way valve with a closed-center spool controls double-acting cylinders which raise and lower the cutter bars. By simply centering this valve control, the operator can hold the cutters at any height.

This type of circuit emphasizes advantages of Denison **Pump/Motors**. Each unit is ready for either pump or motor duty *without alterations!* A single "spare" can replace any of the three units, in any of the boats. **Pump/Motors** are single-stage, vane-type power packages with hydraulically balanced vanes, and simplified three-unit construction. They stand up under *long, hard, continuous duty* at pressures up to 2000 psi. Four sizes—each with a choice of cam rings for different needs—offer pumping capacities from 3 to 82 gpm . . . motor capacities from 8 to 98 hp (13 to 257 inch-pounds of torque per 100 psi.) All models can provide either clockwise or counterclockwise rotation.

*Denison offers an outstanding line of high pressure oil hydraulic pumps, motors and controls, for pressures to 5000 psi. Designed with skill and knowledge gained through twenty-five years of leadership in oil hydraulics, they have the compact ruggedness needed for exacting, heavy-duty demands. Wherever you need closely adjustable power and control with unlimited operating flexibility, specify HydrOILics. Write for more details.*

DENISON HydrOILics

"The Finest Money Can Buy" in Pumps, Motors, Controls and Presses

**The DENISON Engineering Company, 1189 Dublin Road, Columbus 16, Ohio**

# Looking for ACTION?

ILLINOIS GEARS
Reg. U.S. Pat. Off.

*Gears for Every Purpose* ... one gear or 10,000 or more

**ILLINOIS GEAR & MACHINE COMPANY**

Westinghouse pneumatic controls are mounted on one control stand within easy reach of the operator. They assure smooth, safe, effortless handling of all loads.

## Hoist manufacturer reduces operator fatigue with WESTINGHOUSE PNEUMATIC CONTROLS

• To meet the specific recommendations of iron workers who actually use this steel erection hoist, American Hoist & Derrick Co. controls the diesel engine throttle, clutches, and brakes with a pneumatic system supplied by Westinghouse Air Brake Co. Smooth acting pneumatic control gives fast, automatic operation, makes the machine *easy* to operate, and reduces the possibility of error or accident.

Westinghouse pneumatic controls are now giving the same benefits on conveyors, bagging machines, wire drawing equipment, aluminum foil mills, paper machines, and power takeoff devices.

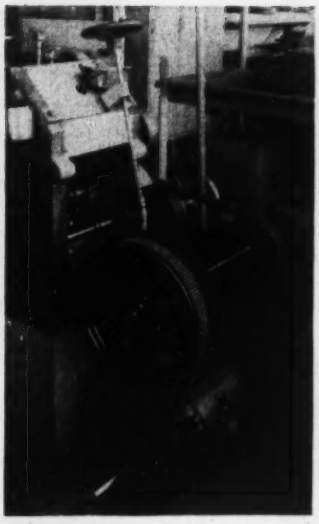
Write for information about the advantages of Westinghouse pneumatic control on your machines.

Westinghouse Air Brake
COMPANY

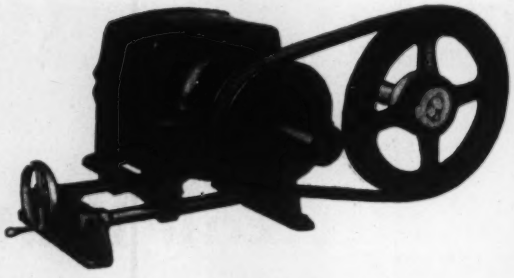
INDUSTRIAL PRODUCTS DIVISION WILMERDING, PENNA.

Factory Branch: Emeryville, Calif.
In Canada: Canadian Westinghouse Co., Ltd., Hamilton, Ontario

## increase machine performance with



## LOVEJOY Variable Speed PULLEYS



**Quickly, easily installed on old or new machines . . . allowing infinitely variable speed adjustments over wide range. A mere turn of hand instantly, accurately speeds up or slows down the driven unit for *changes in production schedules . . . adjustment for operator ability . . . corrections for size or stock, temperature or humidity, size or density.***

**Available in 8 sizes—fractional to 8 hp. with ratios to 3 to 1.**

*Write today for illustrated catalog and complete technical data.*

LOVEJOY FLEXIBLE COUPLING CO.
4832 W. Lake St. • Chicago 44, Ill.

***Also manufacturers of universal joints and flexible couplings***

## SEE RUST-OLEUM APPLIED DIRECTLY OVER SOUND RUSTED SURFACES! MAKE THIS TEST UNDER YOUR OWN CONDITIONS AND SEE PROOF OF PERFORMANCE!

See Rust-Oleum 769 Damp-Proof Red Primer actually applied over a badly rusted surface after simple scraping and wire-brushing to remove rust scale and loose rust in the Rust-Oleum *"rusted panel demonstration."* Rust-Oleum's specially-processed fish oil vehicle *penetrates* rust to bare metal usually eliminating sandblasting and other costly surface preparations.

Rust-Oleum finish coatings in Aluminum, Green, White, Gray, Yellow, Black, Orange, Blue and others provide both *Rust Prevention* and *Decorative Beauty!* Specify Rust-Oleum for new construction, maintenance, and re-modeling. See Sweets for complete catalog and nearest Rust-Oleum Industrial Distributor, or attach coupon to your business letterhead.

# RUST-OLEUM®

# STOPS RUST!

*There Is Only One Rust-Oleum. It Is Distinctive as Your Own Fingerprint. Resists Rain, Sun, Fumes, Snow, Heat, Salt Air, Salt Water, etc.*

See local classified telephone directory under Rust Preventives or Paints for nearest Rust-Oleum Industrial Distributor.

ATTACH TO YOUR BUSINESS LETTERHEAD AND MAIL TO:
**Rust-Oleum Corporation, 2901 Oakton St., Evanston, Ill.**

- ☐ Please Show Me the Rust-Oleum "Rusted Panel Demonstration."
- ☐ Test Application of Rust-Oleum Over Rusted Metal Surfaces in My Plant.
- ☐ Complete Literature with Color Chart.
- ☐ Nearest Rust-Oleum Industrial Distributor.

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The two Gerotors revolve at different speeds, resulting in a continuous opening and closing of spaces as shown in this diagram. Follow the changing position of tooth #1 as rotation takes place. Note its relation to space #2. As rotation continues, tooth #1 gradually displaces oil from space #2, thus creating pressure.

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February, 1954 CARD INDEX Vol. 76, No. 2

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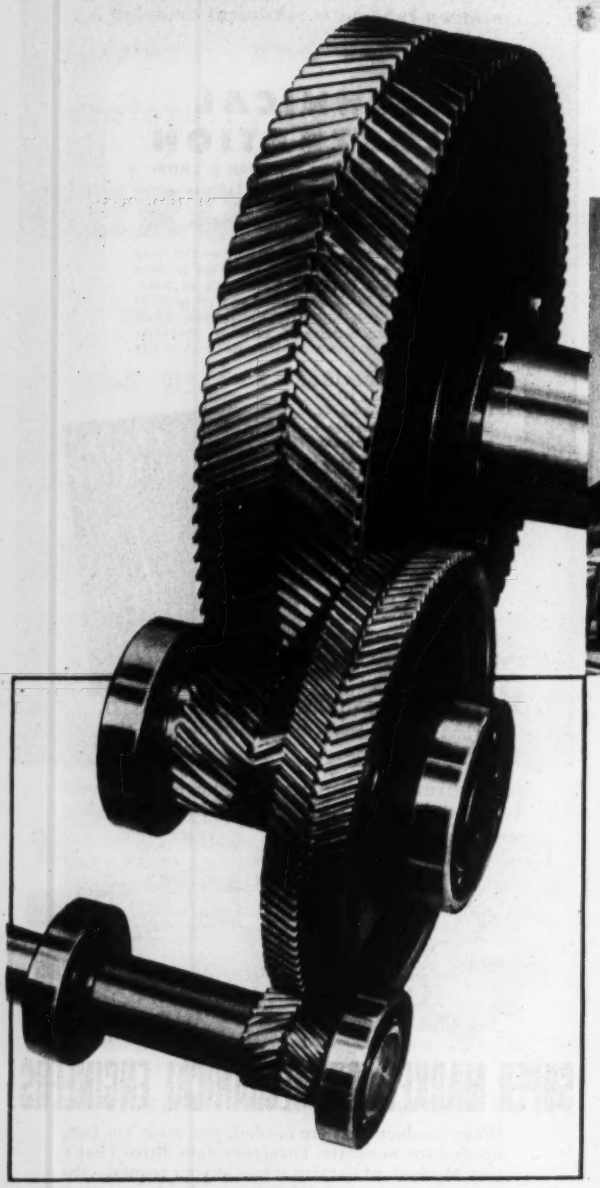
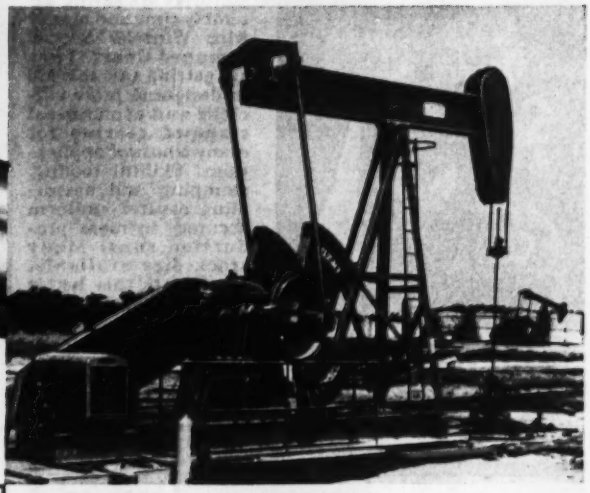
# MECHANICAL CATALOG

*Published annually as a service for members by*

**THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS**
29 West 39th Street, New York 18, N. Y.

# FLOATING ON HYATTS!





## This is a job for straight roller bearings, and EMSCO relies on HYATTS!

Take a good look at these herringbone gears—and at the four bearings supporting the two smaller shafts. These particular herringbones operate in the gear box of EMSCO's newest pumping unit, and the bearings are *Hyatt Hy-Loads!* For oilmen, this is a combination that means longer bearing life and lower maintenance costs, because only *straight radial bearings* permit these gears to locate themselves for most efficient operation. And when the application calls for radial-type bearings, EMSCO engineers specify Hyatts. Hyatts offer the proven advantages of easy assembly, simple maintenance, complete interchangeability of parts, and longer life. Insist on Hyatt Hy-Load Bearings for herringbone gear applications.

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**RATES** Classified Advertisements under this heading in MECHANICAL ENGINEERING are inserted at the rate of $1.70 a line. $1.35 a line to members of ASME. Seven words to the line average. A box number address counts as one line. Minimum insertion charge, 5 line basis. Display Advertisements carried in single column units of multiples of one inch at flat rate of $28 per inch per insertion. Copy must reach us not later than the 10th of the month preceding date of publication.

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Proof of U. S. Citizenship Required

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*mechanical designer*

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MECHANICAL ENGINEER—37, MSME, registered Ohio and Pennsylvania, married, 2 children. 16 years' experience research, design, development of tires, process machinery, new products in medium to heavy machinery field. Address CA-4622, care of "Mechanical Engineering."

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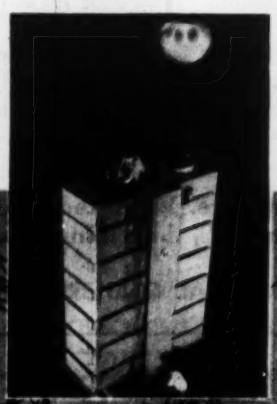
**At right:** Capable of operation on 600-kv transmission line now — possibly on 880-kv line in the future, this 5000-kva commercial-type power transformer proves that Allis-Chalmers transformer engineering is ready for transmission voltages far beyond present levels.



**Below:** Two 90,000-kva banks of load ratio control transformers on 230-kv lines of Southern California Edison Company.

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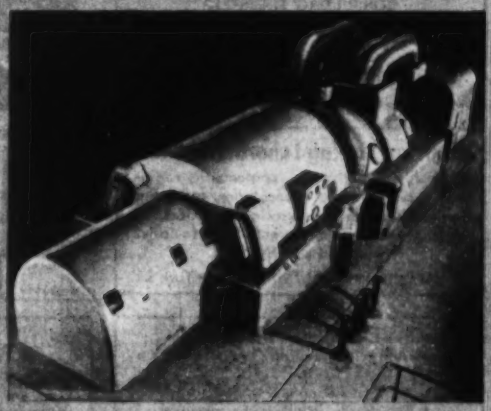
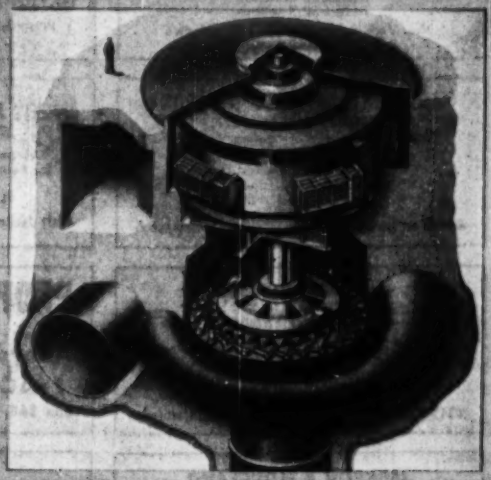


### Reversible Pump-Turbine Units

Pioneered by Allis-Chalmers, reversible pump-turbines can solve some troublesome peak load problems. They do this by reducing the amount of equipment formerly needed for pumped storage operation; the single unit operates alternately as a turbine-generator and as a motor-driven pump. One 20,000-hp pump-turbine is now in operation, and four others are in production, with turbine ratings ranging from 12,650 to 120,000 hp. The latter will combine the world's largest motor, with a rating of 102,000 hp, and the largest Francis turbine ever built.



### Multi-Steam-Path Condensers

Allis-Chalmers is supplying six 100,000 sq ft surface condensers for the 2,200,000 kw of added private utility capacity being provided for AEC's Ohio diffusion plant. A-C multi-steam-path condensers have consistently helped to cut power costs. With 60 years of experience building over 13,000,000 sq ft of condenser capacity, A-C has the proven engineering and manufacturing facilities to build the largest condensers that might be required.

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A-C ALLIS-CHALMERS

*For more information, contact your nearby A-C representative, or write Allis-Chalmers, Milwaukee 1, Wisconsin.*

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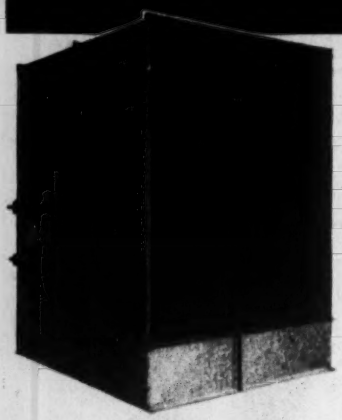

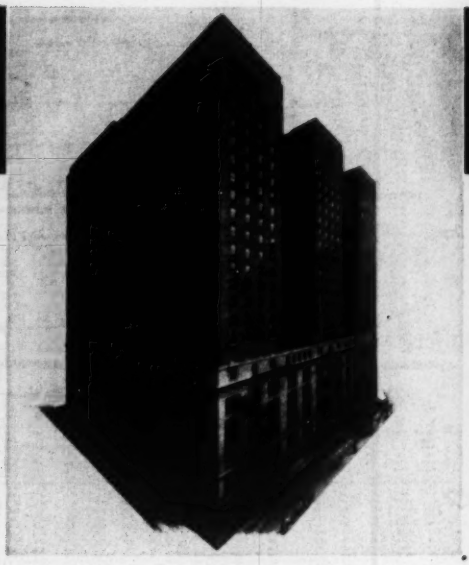

**52**
**FANS**

# operating 29 years and *STILL GOING STRONG*

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***Interesting Facts about this installation as published in Clarage advertising in 1925...***

Architects and engineers for the new Palmer House are Holabird & Roche, Chicago. Clarage Equipment purchased by Phillips Getschow Co., Chicago. Clarage Apparatus when completely installed will comprise what is undoubtedly the world's largest ventilating installation. Supply fans deliver 19.35 tons of air per minute, exhaust fans handle 25.7 tons of air per minute, while the washers use 3,700 gallons of water per minute.

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. . . so reports C. D. Willingham, building superintendent at Chicago's famed Palmer House.

It was in 1925 that the present Palmer House was built — replacing its historically famous predecessor.

The 52 Clarage fans and 22 Clarage air washers installed in this hotel have been **on the job for 29 years.**

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## deliver highest purity makeup for SHELL

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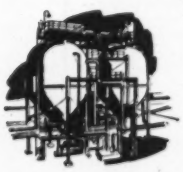

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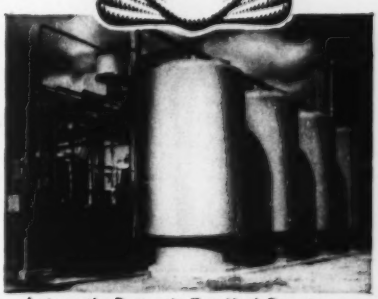
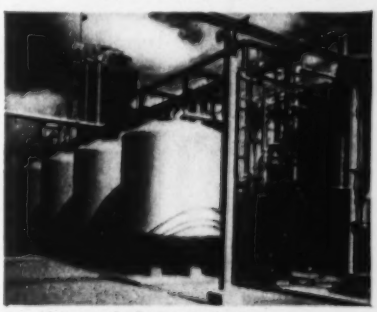


Automatic Permutit Zeo-Karb® units remove metallic cations from Shell's well water supply. Effluent passes to Degasifier at right for low cost $CO_2$ reduction.



Automatic Permutit S units remove remaining troublesome mineral impurities by anion exchange.

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ION EXCHANGE AND WATER CONDITIONING HEADQUARTERS FOR OVER 40 YEARS

# Achieves high production, high precision of difficult jet engine part

## ...with help of TIMKEN® bearings

TO insure high-speed precision machining of compressor discs for the J-34 turbo-jet engine, four Gisholt 4F Fastermatic Automatic turret lathes are set up in a two-man "production line". Each operator tends two lathes and they perform all machining in four pass-along operations.

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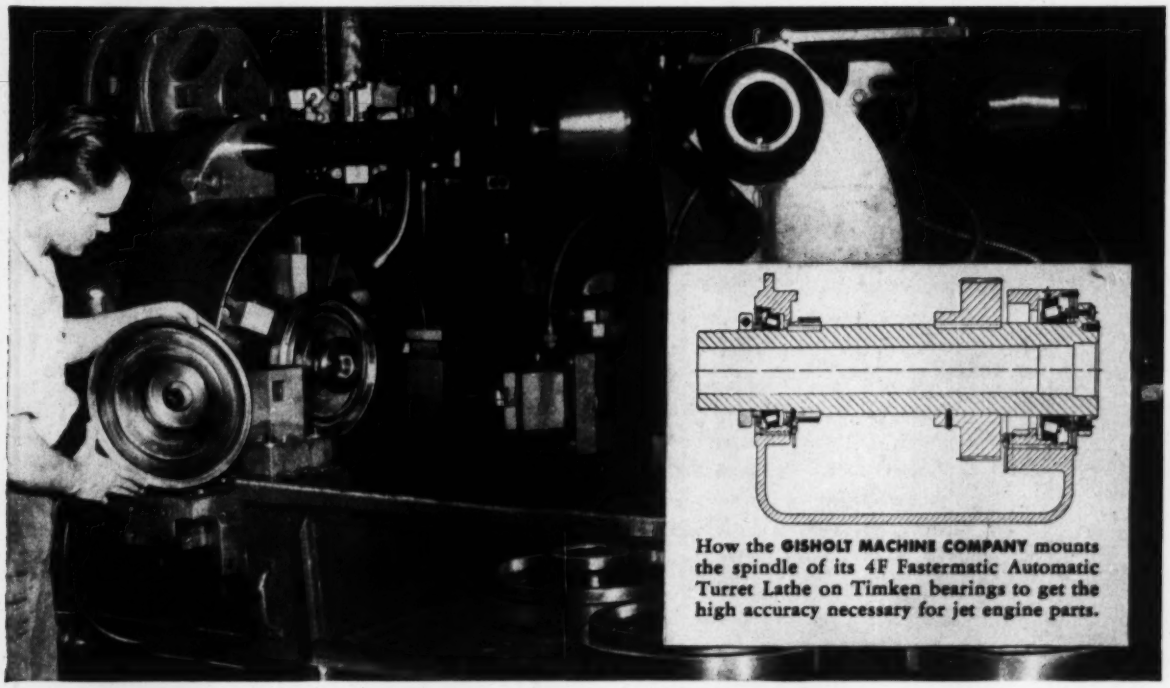
Gisholt makes sure these lathes operate with high precision by mounting the spindle and gear train on Timken® tapered roller bearings. The spindle has adequate capacity for any load; line contact between rollers and races of Timken bearings provides load-carrying capacity to spare. And the tapered design of Timken bearings enables them to take radial and thrust loads in any combination. This holds spindles rigid and permits pre-loading to any desired degree to prevent chatter.

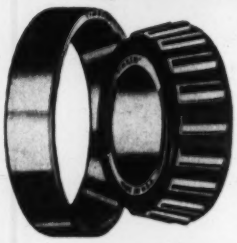
Timken bearings practically eliminate friction because of their true rolling motion and smooth surface finish. Made from Timken fine alloy steel—finest steel ever developed for tapered roller bearings—Timken bearings' rollers and races are case hardened for hard, wear-resistant surfaces and tough, shock-resistant cores. As a result, wear is reduced, maintenance minimized.

Next time you buy or build a machine tool, make sure it's equipped with Timken precision tapered roller bearings. Always look for the trade-mark "Timken" stamped on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

*This symbol on a product means its bearings are the best.*



How the **GISHOLT MACHINE COMPANY** mounts the spindle of its 4F Fastermatic Automatic Turret Lathe on Timken bearings to get the high accuracy necessary for jet engine parts.



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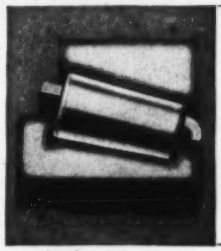

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